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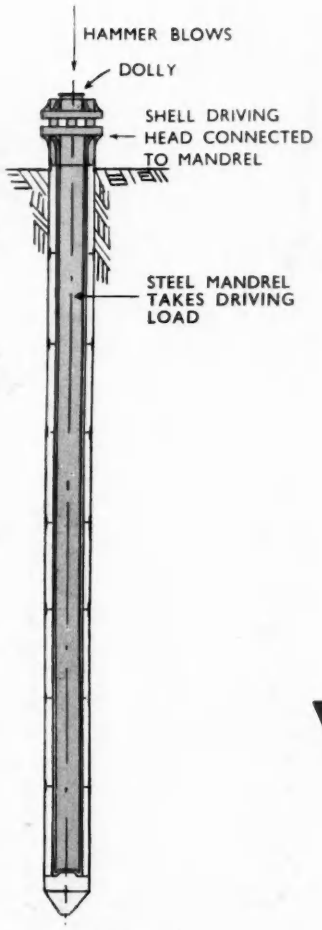

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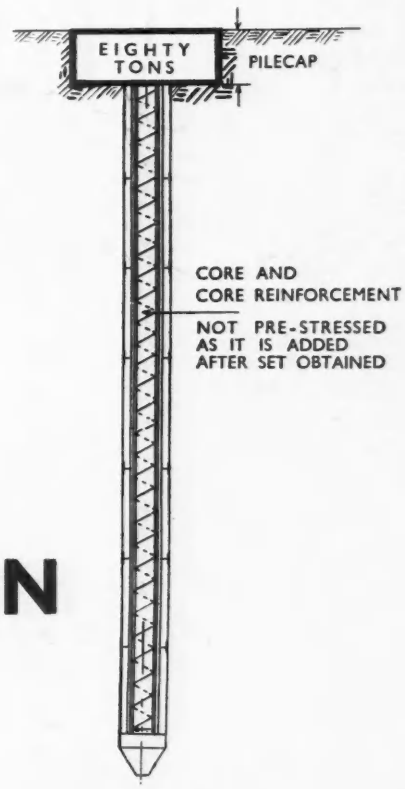

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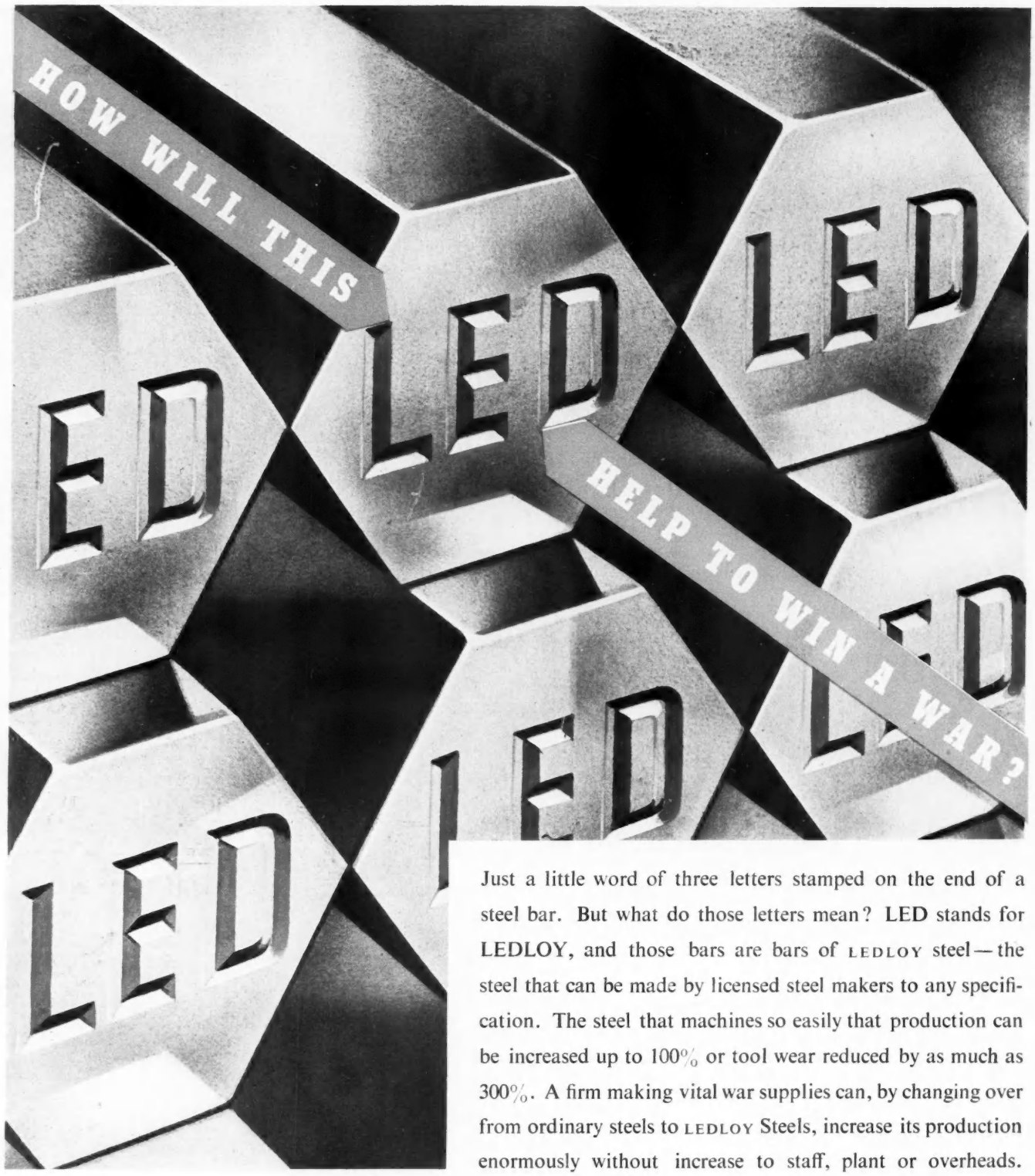

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Ship Contracts and Repairs

SOME important recommendations with regard to the repairing of ships are made in the report of the Select Committee on National Expenditure which has just been published. The Committee recommends closer contact between the indenting department of the Admiralty, which is responsible for specifications and quantities, and the Director of Contracts, whose department is responsible for prices. Such close association is necessary, it is held, in order to ensure that specifications are kept under constant review from the point of view of cost. In the case of ship repair and conversion work, it is suggested that the practice of fixed price contracts should be reverted to without delay, except where for special reasons it is impossible to do this. If it is still necessary to do work on the cost-of-labour and material-plus-profit basis, then adequate detailed supervision should be ensured. In the interest both of keeping down costs and maintaining the efficiency of labour, overtime in shipyards should, it is recommended, be carefully watched, and Sunday work in particular should be restricted, except in cases where it is definitely necessary. The Committee states that the evidence shows that prolonged spells of overtime have led to a sharp rise in sickness, and apart from the loss of efficiency there was the effect on costs. When double rates and even more were earned on Sundays, the addition to the cost of a job was considerable. As the employers were paid on a cost-plus-profit basis, it was not in their financial interest to avoid Sunday labour, for the higher the cost of a job, the higher the profit they were likely to obtain.

Aircraft Production

IN his preface to a statement on increased aircraft issued on Sunday evening, July 7th, Lord Beaverbrook, the Minister of Aircraft Production, reminded his readers that he was an optimistic man, with all the defects and benefits that go with optimism. Optimistic men, he went on to say, were sure to see the advantages in a situation. They always felt confident about overcoming the obstacles. The hard facts were as follows :—The production of aircraft during the month of June had achieved a record. There had been a very fine increase over everything that had gone before, and more than double the total of aircraft had been produced compared with the same month of last year, when preparations for war were going in full blast. Compared with the same month of the last year, we also turned out far more than twice the number of aircraft engines, thereby increasing our surplus stock. With regard to the orders for aircraft and engines which had been placed in the United States of America and in Canada, that story was told by the account books. The American aircraft which were now arriving here represented a considerable contribution to our air fleet, and if the seas remained as free as they were to-day, then the shipments of aircraft which would reach us from America would give an additional output in every month, which would be of real value to us. During recent weeks we had purchased immensely increased quantities of aircraft and engines in the United States, the orders totalling in all to well over 1000 million dollars. In Canada we had bought over 50 million dollars worth of aircraft and parts, and deliveries of certain types were coming forward in increasing quantities. Lord Beaverbrook said that such figures should not lull us to sleep. He was well aware that there was much to do before we could be satisfied with our achievements in production. The Ministry would not fail, he prayed, in the task which the Prime Minister, Mr. Churchill, had allotted to it.

Increasing Munitions Production

ON Monday afternoon, July 8th, a conference took place at the Ministry of Supply between the Minister, Mr. Herbert Morrison, and the managing directors and other leading members of firms engaged in war contract work. In opening the conference, Mr. Morrison invited frank and candid comment and suggestion as to measures which might be taken to quicken the production of munitions and arms supply. The industrialists who were present readily responded to the Minister's invitation, and a number of constructive proposals and criticisms were put forward and duly noted. Among the more important matters which were raised, the following may be mentioned :—The rationalisation of production of certain essential items; the simplification of procedure in ordering; new methods for ensuring the discovery and full use of spare capacity; the employment of substitute materials; closer consultation between manufacturers and the Ministry in working out new specifications; and further relaxation of inspection. The discussions which took place were freely contributed to, by both representatives of the manufacturing firms and the officers of the Ministry. Ideas which were put forward were fully discussed and their examination made it clear that the Ministry looked to the industry to indicate the way to improve the conditions in the sphere of operations of which they had the most direct knowledge. At the conclusion of the conference, Mr. Morrison gave his promise that every new suggestion which had been put forward would be examined. In several cases the Minister was able to assure the conference that steps had already been taken which would give effect to the ideas put forward. A feature of the conference was the very wide range of works represented, which included both large and small factories in all parts of the country which are engaged in the most varied types of engineering production work.

Evacuation of Engineers' Children to Canada

As we announced in a paragraph in last week's issue, the Institutions of Civil, Mechanical and Electrical Engineers have received through the Engineering Institute of Canada a generous offer by which members of the three Institutions who are sending their children to Canada for the period of the war under the Government's children's overseas reception scheme, and who have no relatives or friends in that country to whom to send them, could arrange for their children to be received into the homes of Canadian engineers. Further information is now available regarding this scheme. Applications can be received at present only from those members of the above-mentioned Institutions who have already registered under the Government's scheme. A member who has so registered and who wishes to take advantage of the offer of the Engineering Institute of Canada should inform the Secretary of his Institution immediately. When he receives the official notice of acceptance he should again get in touch with the Secretary of his Institution, and the latter will furnish him with a certificate to ensure that the child in question is included in this scheme, for submission with the acceptance form. In order that a complete record may be kept of the children who are to be received into the homes of Canadian engineers, members are asked to inform the Secretaries of their Institutions as soon as the child leaves home for the port of embarkation. Members who have not registered their children but who are interested in this scheme should so inform the Secretaries of their respective Institutions pending the re-opening of registration.

Spanish Handbook on British Industrial Practice

THE British Standards Institution is engaged on the compilation of a technical handbook in the Spanish language, the object of which is to make known to prospective purchasers in South America what British industry has to offer. It will also bring British industrial practice prominently to the attention of importers, salesmen, young engineers and others and correct any misapprehension which may exist regarding the competitive character of British goods and their suitability to those markets. The British Council is lending its full support to this effort and will assist in giving publicity to the handbook and in furthering its distribution throughout the whole of South America. A Committee of Direction under the chairmanship of Dr. T. Swinden, of the United Steel Companies, Ltd., composed of a number of experts, which was set up to examine the project, unanimously decided that the handbook should cover all those branches of industry interested in South American trade. It will be the forerunner of other volumes dealing in far greater detail with individual industries, which will be undertaken at a later date when the technical staffs are able to turn their attention from matters relating to the war effort. A supplement to the handbook is being prepared which will give British exporters an opportunity of bringing to the notice of South America, through textual and display advertisement , their own particular products. The supplement will be given away with each copy of the handbook sold. The B.S.I. has circularised trade organisations and export groups likely to be interested, but any individual firms who have not up to the present received details of the project, if they are interested, are invited to communicate with the Institution at 28, Victoria Street, London, S.W.1.

Employment Returns

IT was officially announced by the Ministry of Labour and National Service on Monday evening that between May 20th and June 17th there was a reduction of 113,987 in the number of unemployed persons on the registers of employment exchanges in Great Britain. The total of 766,835 for June 17th, 1940, was 582,744 less than the figure for June 12th, 1939. The reduction in unemployment affected all areas and most industries. The industries showing the greatest reductions between May 20th and June 17th in the numbers unemployed included building and public works contracting, the distributive trades, coal mining, agriculture and horticulture, dock and harbour service, local government service, and the cotton industry. On the other hand, unemployment increased in the tailoring, dressmaking, and millinery industries. An analysis of the number of unemployed shows that the total of 766,835 on the registers on June 17th is made up of 382,337 men wholly unemployed and 38,681 temporarily stopped, these men being normally in regular employment. There were 35,390 unemployed men who normally are in casual employment. Similar figures for boys are 14,047 wholly unemployed, 988 temporarily stopped, and 94 normally in casual employment ; for women employees the figures are 225,777; 39,522; and 1654; and for girls, 26,153; 2189; and 3. The largest reductions in the number of unemployed persons occurred in the London, North-Western, and Northern divisional areas, and in Scotland and Wales.

The French Battleship "Richelieu"

SPEAKING in the House of Commons on Tuesday evening, July 9th, the First Lord of the Admiralty, Mr. A. V. Alexander, gave particulars of the attack on the French battleship "Richelieu" at Dakar, after the French officers did not accede to the British proposals for rendering the ship useless to the enemy. The attack upon the "Richelieu" was, he said, two-fold. A ship's boat under the command of Lieut.-Commander R. H. Bristowe was sent into harbour carrying depth charges. With great daring the motor-boat successfully passed the boom defence and went alongside the port quarter of the "Richelieu," and at the right moment depth charges were dropped close under the stern of the warship as she lay at anchor in shallow water, in order to damage her propellers and steering gear. The motor-boat began to withdraw immediately after dropping depth charges, but while still in the harbour broke down, and lay helpless for a time. The crew, however, succeeded in getting one engine running just as they were discovered, and the boat, which was pursued, managed to escape by crossing the harbour defence nets, which held the pursuers. The main attack was entrusted to the aircraft of the Fleet Air Arm, and took place after the attack by the motor-boat. The aircraft were successful with their torpedoes, a number of which hit the "Richelieu." The motor-boat, which was still in the harbour, witnessed the aircraft attack and heard five explosions. Air reconnaissances since carried out have established that the "Richelieu" has a list to port, and is down by the stern. A large quantity of oil fuel covers the water round the ship. All our aircraft returned safely, in spite of heavy anti-aircraft fire.

The Centenary of the London and Blackwall Railway

JULY 4th, 1940, marked the centenary of the opening of the "Commercial Railway," so designated because it was designed to convey passengers and goods from London to the India Docks. It was soon, however, called the London and Blackwall Railway. The first terminus was in the Minories, as in those days the "City Fathers" refused to sanction a railway within the exclusive square mile of the City. Four years later, however, that decision was rescinded, and the Fenchurch Street terminus was opened in the summer of 1842. The line of 1840 consisted of two tracks alternatively up and down of 5ft. gauge, constructed on arches for a distance of 3¼ miles from the Minories to Blackwall. Rope traction was chosen, on account of the densely populated district through which the railway passed and the fear of fires which might have been caused by hot cinders from locomotives running on a level with the upper floors of the houses. There were five stations, Poplar, West India Dock, Limehouse, Stepney and Shadwell. Seven-coach trains were run at quarter-hour intervals and trains started from each terminus at the same time, on the north and south lines in turn. Carriages were slipped at each intermediate station and were re-assembled at the terminus. By this manner of working the trains were non-stop to and from both termini, and the other stations. In view of further extensions the company obtained at a later date powers to reduce the gauge from 5ft. to 4ft. 8½in. and to abandon the principle of rope traction which was first employed. The branch from Stepney to an interchange junction with the Eastern Counties Railway at Old Ford was opened on April 1st, 1849, and by that date, less than ten years from the opening of the railway, the whole of the system was worked by locomotives.

Automatic Train Control

No. I

THE comment is very often heard nowadays upon railway accidents, both slight and serious, that some form of automatic train control would have saved the situation. The circumstances which cause the comment to be made are often extraordinarily diverse, and A.T.C.—to use the abbreviated form—is in many quarters still looked upon as a vague, yet highly desirable, system of perfection, that, were it financially practicable, would eliminate once and for all the human element in train operation. The different systems coming within the general term " automatic train control " are almost as diverse as the circumstances in which its adoption in some form or another has been suggested, and before proceeding to a general survey of the position in various parts of the world at the present time, it is necessary first to analyse the more frequent causes of accidents in order to gain a clear idea of what A.T.C. is required to do.

Briefly, it may be said that A.T.C. is required to furnish an additional safeguard to provide against the chance of a driver misreading or disobeying the wayside signals. It need not necessarily imply taking the control of the train out of his hands. A typical example is provided by an express train travelling at high speed and coming in due course to a distant signal showing the caution indication. From their regular workings, drivers get to know where delays are most frequently experienced, where the margins between conflicting movements are close ; but in the hypothetical case under consideration the adverse signal is encountered at a location where in the course of several years' working of the express in question a delay has never been experienced. It is therefore totally unexpected, and from his familiarity with the working, the driver is a little less alert than he might be. Atmospheric conditions or steam from another train may make the sighting of the signal not too clear, and as a result of these various factors several valuable seconds may elapse before the driver fully realises he is being cautioned. If the speed is 80 m.p.h., it only needs 5 sec. hesitation to be deprived of 200 yards of valuable braking distance. This might conceivably make all the difference between a safe stop and a dangerous overrun at the home signal.

In such a case an audible signal in the cab, without any brake-controlling device, would most likely provide all the necessary additional safeguard, for in this instance it is assumed that the man has acted upon the wayside signal indication, though tardily. More serious consequences would result in similar circumstances through the misreading of the distant signal ; then it is that some definite control of the train is needed to counteract the effect of the driver's mistake. Here, in the very first case considered, is a thorny point for the administration to decide—do accident records suggest the need for a definite " control " feature, or will some form of cab signalling alone provide the additional safeguard required ? Without relating it to other operating conditions, it is almost impossible to give a generally applicable answer.

Any system of A.T.C. or cab signalling is bound up with the various forms of wayside signalling on the route in question, and with the brake power of the trains. Considering first a stretch of double track main line, the traffic may be divided into four groups :—

(*a*) Express passenger trains, running at 65 to 80 m.p.h.

(*b*) Partially or fully braked express goods trains, running at 45 to 60 m.p.h.

(*c*) Local passenger trains, not exceeding 60 m.p.h. between stops.

(*d*) Loose coupled goods or mineral trains.

The signalling may be either manual block with semaphores, as illustrated in Fig. 1, or a system of continuous colour-lights, spaced so as to provide a uniform headway, irrespective of the rise and fall of the gradient profile. The colour-light system may be either three or four-indication, according to the headway required with the various classes of traffic.

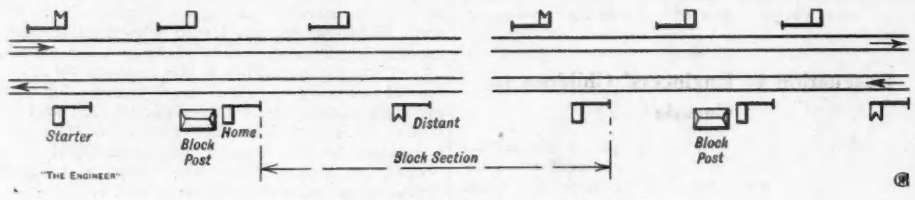


FIG. 1—SEMAPHORE BLOCK SIGNALLING

Continuous colour-light signalling, as shown in Fig. 2, does in itself provide a valuable additional safeguard in traffic operation, particularly in mist or foggy weather, and in certain localities the installation of such systems has been considered sufficient protection to obviate the need for any form of definite control ; but for the purpose of this argument it is now assumed that something additional to the wayside signals is deemed necessary. In the lay-out shown in Fig. 1, the line will not be track circuited, save perhaps for a few isolated lengths within the limits of the interlocking areas at the stations. Any form of control and audible signalling in the engine cab will have to be based upon the indications displayed by the wayside signals ; it will thus be intermittent. Such control will provide a safeguard only against a driver's mistake, for the operation of the block system remains entirely in the hands of individual signalmen. " Interlocking block," or " lock and block " as it is more usually termed, is in use on some lines, though even with this refinement the system is not by ny means foolproof.

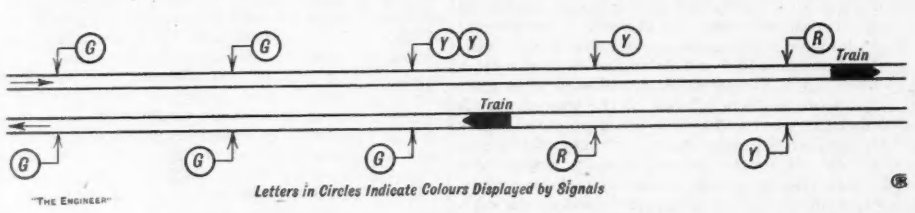


FIG. 2—CONTINUOUS FOUR-ASPECT COLOUR-LIGHT SIGNALLING

A diversity of opinions has always existed as to where and how control should be applied to trains passing through manual block territory. One of the simplest, and most generally adopted practices is to base control upon the indication displayed by the distant signal. The distant is the warner for the whole station area, and the sight of it at danger should be enough to put a driver instantly on the alert ; on the other hand, when it is " off " he can drive on at speed, in full confidence that the road is clear. Some audible signal in the cab verifying the indication displayed by the distant signal at the line side therefore provides a very valuable additional safeguard. But in applying " control," also based on the distant signal, the diverse conditions of train operation have to be taken into account. Technically, it would be quite a simple matter to apply the brakes, irrespective of any action the driver might take, whenever a train passes a distant signal displaying the caution aspect ; but in this country, at any rate, a dead stand at the home signal is compelled in probably not more than 5 per cent. of the instances in which trains have to slacken speed on account of an adverse distant signal. Indiscriminate control would thus result in a great number of unnecessary stops, and so, in the interests of practical traffic operation, some feature is desirable in the equipment that will allow a driver to retain control of the brakes and cause them to be automatically applied only in case of negligence.

Misinterpretation of the distant signal indication is not, of course, the only likely instance of a driver's mistake in manual block territory. Many unfortunate accidents can be recalled that arose through the misreading of starting signals. The track lay-out shown diagrammatically in Fig. 3 may be considered in connection with this point. Here mistakes have sometimes been made, jointly by the platform staff and the crew of a train waiting to leave, the result of which has been the signalling of the " right away " in dangerous circumstances. The train has duly pulled out on to the main line when actually the road has been set for a non-stopping train to pass through on the centre track. In such circumstances, the application of audible cab signalling, with or without the brake control feature, would provide an instant warning to a driver that something was wrong. Many other specific instances could be added where something additional to the ordinary wayside signals would be valuable, but the mere compiling of a list of

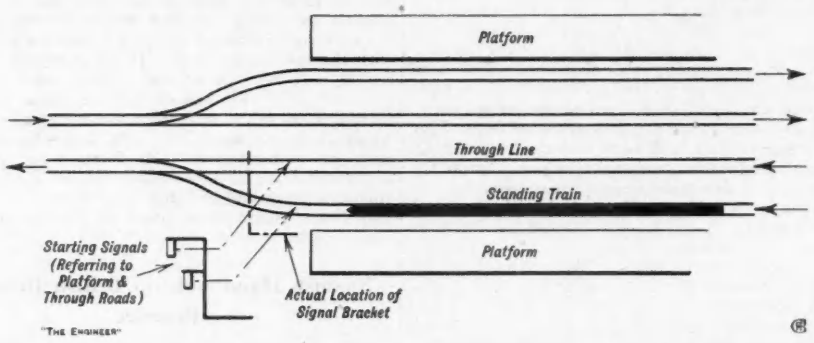


FIG. 3—STATION STARTING SIGNALS

locations to be treated only adds to the complexity of the problem to be solved by any one administration.

In the past many systems have been tried out in various parts of the world with the joint purpose of testing their technical performance and of examining their suitability for the conditions obtaining on the particular railway. Nowadays, however, many thoroughly reliable systems are available. Some are simple and comparatively cheap, others are very costly, and the problem to be faced by any administration desiring to install A.T.C. is to decide what is the best scheme for the money available. Financial considerations do, indeed, play a large part in any such proposals, for, unlike most modern signalling plans, the installation of A.T.C. can hardly be expected to produce any pronounced saving in working expenses. This series of articles is, however, not primarily concerned with the problems of A.T.C. as they appear to a railway administration ; that side of the question is only touched upon as illustrating one potent factor underlying technical development in the various countries.

It is not only due to financial considerations that the position differs so greatly in various parts of the world. Psychology, national temperament, and even climate are factors that have to be taken into account, while the need for basing A.T.C. upon the existing wayside signalling has in some instances resulted in the establishment of systems diametrically opposed in principle. An overwhelming proportion of French railway mileage, for example, is operated upon the principle that no signal at all constitutes " all clear " ; the picturesque chessboards, discs, and triangles revolve in such a manner that only their edge is displayed for the

proceed indication. This is illustrated in Fig. 4. This principle was followed in the designing of a system of cab signalling, now in widespread use, in which an audible signal is given to the driver only when caution is required. As compared to the British practice of giving two dissimilar audible signals, one for caution and one for all clear, the French system has the obvious weakness that a failure of the signal to sound might be taken as an "all clear." Dangerous conditions can well be imagined if visibility were bad, the wayside signals were partially obscured, and the driver was relying upon his cab signal. But, however this system may be regarded by British engineers, it has given excellent service for many years.

Elsewhere, and notably on the German State

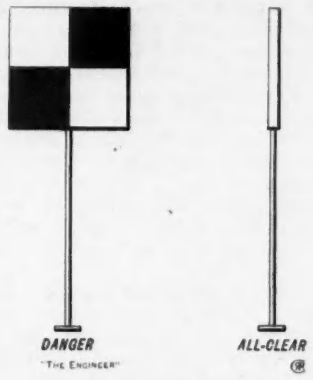


FIG. 4—FRENCH STOP SIGNAL

Railway, cab signalling is not used at all, and although a comprehensive system of intermittent train control has been extensively installed, insistence is made upon the driver's observation of the wayside signals. Here, however, climatic conditions have been partly responsible for the establishment of this principle, for while the frequent occurrence of thick fog in the winter is one of the reasons for the attention given to cab signalling in this country, the "pea soup" variety is practically unknown in Germany. The need for cab signalling, purely as an aid to keeping traffic on the move, is therefore not so great.

The history of A.T.C. and cab signalling is strongly reminiscent of that of signalling itself, in that it was first devised as a means of preventing accidents, and has later come to be regarded as a valuable aid to expediting train operation. The

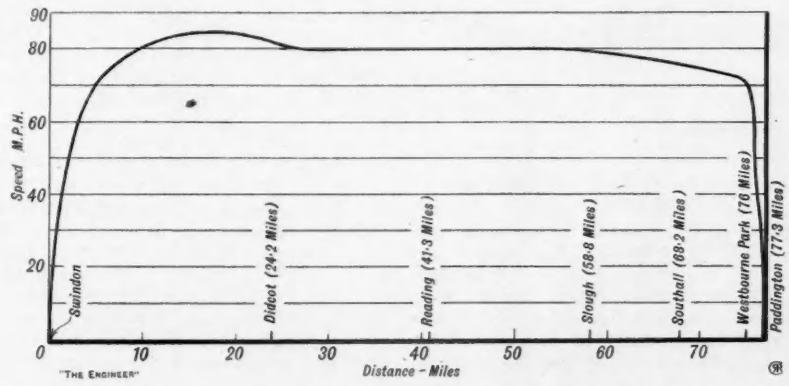


FIG. 5—SPEED CHART OF THE "CHELTENHAM FLYER," G.W.R.

value of intermittent cab signalling in fog, snow, or other conditions of bad visibility has been remarkably demonstrated by operating results obtained on the Great Western Railway. Instances have been recorded wherein the "Cheltenham Flyer," booked in pre-war days to average 71·4 m.p.h., start to stop over the 77·4 miles from Swindon to Paddington, has run practically to normal schedule times on days when thick fog has prevailed in the Thames Valley. The speed required intermediately is shown on the graph in Fig. 5. These results, of course, show, too, that other traffic was running in its normal path, otherwise the crack trains would not have obtained the clear road recorded in these instances.

The intermittent form of A.T.C. and cab signalling is bound to figure prominently where this country is concerned, for almost the whole of the mileage over which fast running is performed is signalled on the manual block system. The longest stretch of continuous colour-light signalling in Great Britain, the 42¼ miles from Skelton Junction (York) to Darlington, represents no more than 8 per cent. of the length of the complete East Coast route from London to Aberdeen. Yet this is by far the highest proportion to be found on any of the trunk lines running north and west from London. The nearest approach to complete colour-light signalling is to be found on the electrified main line of the Southern Railway from Victoria to Brighton, with 38 miles out of a total of 51 equipped. Comparison of these figures with those of a single American railway, the Pennsylvania, helps one to appreciate why continuous cab signalling and train control have been applied so extensively in the United States of America. The Pennsylvania has some 6600 track miles equipped with continuous track circuiting and automatic signals.

Such a comparison is, however, entirely one of statistics. Installation of automatic train control apparatus in America has been mainly compulsory, as a result of two orders, in 1922–24, of the Interstate Commerce Commission. While much of the extensive experience acquired in this wholesale introduction of A.T.C. has been dearly bought, the general trend of development to-day is extremely interesting. The purpose of the orders just mentioned was to increase safety, and certain railways were required to equip specified sections of the line with some form of automatic train control. There were variations in detail, but, broadly, only two systems—intermittent and continuous—were installed. Continuous control involved keeping a constant check upon the speed of the train, and since it was considered desirable that the driver should retain control and make any reduction of speed necessary, cab signals were included in the equipment. In these signals the indication was displayed continuously, signifying high, medium, or low speed, according to the state of the road. If the cab signal changed to a more restrictive indication, say, from high to medium speed, control would be taken out of the driver's hands if he failed to act upon the instructions thus given.

The adoption of the continuous A.T.C. system has led to some striking developments. On one railway the safety in working obtained led to the abolition altogether of wayside signals on one stretch of line, reliance being placed upon the cab signal indications, with the safeguard of the train control equipment in the case of a driver's error. Now it seems as though the wheel is coming full circle, and continuous cab signalling, once merely an accessory in the train control system, is likely to be established as the main feature of future installations designed to provide increased safety in operation. On the Pennsylvania, for example (see Fig. 6), not only is the brake control system being abandoned altogether, but construction is now well advanced upon a 50-mile long installation of continuous cab signalling where no wayside signals will be employed. The scheme is presumably experimental, but the administration evidently have sufficient confidence to dispense with the train control feature, too, and place entire reliance upon the continuously controlled cab signals.

For automatic train control to be fully effective, every locomotive passing over the stretch of line concerned must be equipped. Even within the confines of Great Britain there are great difficulties in this respect, particularly since the grouping of the railways seventeen years ago into four main line companies. On the L.M.S. and the L.N.E.R. locomotives are rostered to work long and complicated itineraries, between leaving their home shed and returning thence, and one may find, for example, an Ayr and Glasgow express hauled by a locomotive from Patricroft shed, Manchester. As a result of this intensive use of motive power, it follows that the locomotives running over any one section of line may belong to depots on almost any part of the system, and with the week-to-week changes in the rostering of individual engines, a great number would require to be fitted with A.T.C. apparatus if the equipping of any one stretch is to yield the best results.

The installation of the Hudd system of intermittent inductive train control on the former London, Tilbury and Southend Railway provides an interesting example (see Fig. 7). This particular section of the L.M.S. is almost entirely self-contained, so far as motive power is concerned, and

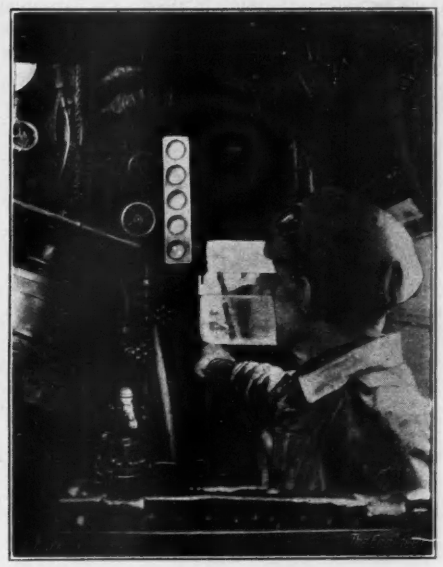


FIG. 6—CONTINUOUSLY CONTROLLED CAB SIGNAL—PENNSYLVANIA RAILROAD

the fitting of A.T.C. equipment to about 100 locomotives means in practice that every train in the suburban rush hours has this additional protection. Of course, there may be occasional instances of special trains to the popular resorts served by this line worked through from other parts of the L.M.S. system by locomotives that are not equipped. In such cases, however, the engine crew, being most likely strange to the line, would be accompanied by a pilotman, and this in itself would ensure the keeping of an extra sharp look out. The extensive trial of the same system on the L.N.E.R., between Edinburgh and Glasgow, now in course of

FIG. 7—TRACK INDUCTOR, HUDD A.T.C. SYSTEM

installation, is also being made on a section of line over which there is a comparatively small number of locomotives regularly operating.

It does not necessarily follow that because a certain stretch of line is already equipped with complete track circuiting and colour-light signals that when A.T.C. or cab signalling comes to be added it must be of the continuous kind. The intermittent systems have the advantage in this respect that they can be applied equally well to both manual block and continuous colour-light territory. Thus, on the East Coast route, supposing intermittent A.T.C. were installed on the busy 32-mile stretch from King's Cross to Hitchin—almost entirely manual block—and again through the territory of continuous colour-light signalling from York to Darlington, the cab equipment of locomotives working through from London to

Newcastle would respond satisfactorily on both stretches, even though the wayside signalling on which it is based is quite different.

A final point to be considered before going on to discuss the various systems in their technical details is the types of locomotive to be equipped where financial considerations preclude the fitting of every motive power unit operating over the section of line where A.T.C. is installed. Preference in such cases would naturally be given to the top link express locomotives, also to tank engines or electric motor coaches engaged in close headway local traffic. There are, however, many units, which by the very nature of their duties are much less likely to meet adverse signals. This point may be illustrated by the case of an important long-distance express calling at a large intermediate centre. To serve wayside stations a local train leaves shortly after the departure of the express, on the same track. Such a local, running in a country district, is not likely to receive signal delays, and its locomotive can well be one of those from which A.T.C. equipment might be omitted for the time being. Shunting engines, local service railcars, and locomotives engaged upon slow pick-up goods traffic can also be excluded. Such elimination is, of course, only a compromise between practicable politics and the ultimate ideal; and the same might be said of all A.T.C. work, everywhere, save perhaps in the United States of America.

(To be continued)

Steel Pile Bridge Piers on Canadian National Railways

THE bridge practice of the Central Region of Canadian National Railways is already well known in North America and to some extent in Europe. The economical use by C. P. Disney, Bridge Engineer, of large pre-cast reinforced concrete bridge deck units is now far from being a novelty; corresponding bolting of rails directly to reinforced concrete deck slabs (with no ballast) has passed from the experimental stage to accepted practice. One of the earliest applications of the latter practice was described in THE ENGINEER for August 16th, 1935, "The Vaudreuil Rigid Frame Bridge." The same engineering office has now pioneered another innovation in Canadian bridge practice, the use of steel bearing piles for forming bridge piers. Originally devised to meet an unusual foundation condition, this new type of pier has proved so economical and convenient that it has already been adopted by the C.N.R. for several important bridge reconstructions. It is a type of design with wide applications; the leading feature of its first uses are therefore given in the following notes and in the accompanying illustrations so that engineers elsewhere may benefit by the C.N.R. experience.

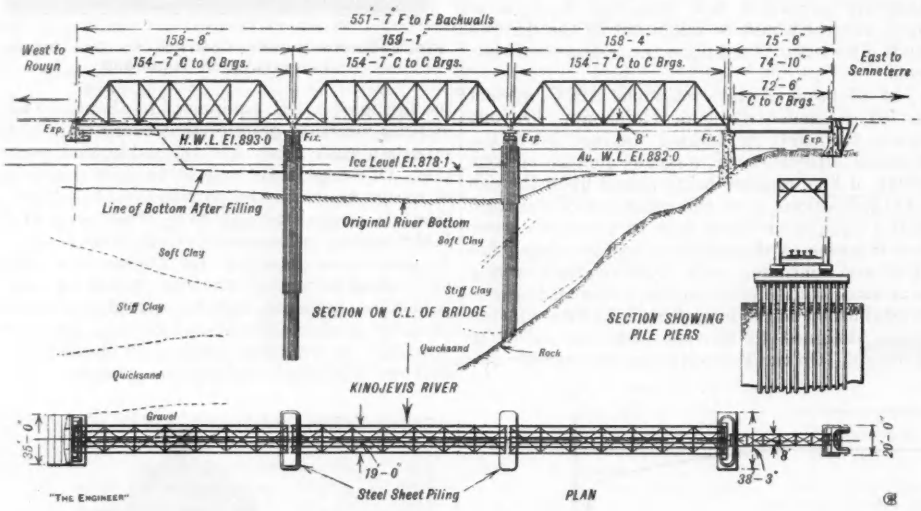


FIG. 1—DIAGRAM OF THE KINOJEVIS BRIDGE

KINOJEVIS BRIDGE

The north-western part of the province of Quebec has developed rapidly in the last few years as an important mining area—the name Noranda is one known even in England. To serve this growing area Canadian National Railways have recently completed an important new branch line between the town of Rouyn and Senneterre, on the Transcontinental line running westwards from Quebec City. This new line serves a good number of newly developed mining properties; consequently, the topography through which it passes is typical of the Canadian Shield, that immense water-studded area of Pre-Cambrian rock. Several important water crossings therefore occurred in the branch line construction.

One of the most important of these was across the Kinojevis River, about 10 miles east of Noranda. The most economical situation for the crossing provided a bridge site with unusually bad foundation conditions. The best alternative site would have increased the length of the track by 3 miles with increased gradients and excessive curvature so that the C.N.R. Bridge Department proceeded with the design for the original site after all necessary surveys and test borings had been completed. Water depth at the site went to 30ft.; then came about 80ft. of soft "soupy" clay, 50ft. of stiffer clay, and about 50ft. of quicksand overlying gravel. Solid rock was encountered in borings on the east bank, but it dipped very steeply and so was of no avail as a foundation stratum. A conventional design for the necessary bridge piers was first investigated, assuming mass concrete construction supported on bearing piles. The cost and nature of the necessary cofferdams rendered this scheme prohibitive in cost, if, indeed, it was even practical. As a result of much further study the new steel pile pier design was evolved.

Essentially, this new departure from standard practice consists in the use of steel H bearing piles, driven to unusually great depths, and used not only as the bearing structure below ground, but also to form the pier itself. Above ground level the steel piles in each group are suitably braced together, all connections being welded, and a suitable welded steel bearing grillage is used as a cap to transmit the bridge load to the bearing piles. As may be seen from Fig. 1, this type of construction was used for the two main piers of the Kinojevis River bridge. The superstructure of this bridge consists of three through-truss spans each 154ft. 7in. between centres of bearings, and one 74ft. 10in. deck plate web girder span. This arrangement was selected from considerations of the site and also of the fact that second-hand steel spans of the dimensions noted were available for use. A large rock fill on the west side of the river considerably shortened the actual bridge length, being consolidated into its supporting stratum by depth charges of dynamite. The bridge is 551ft. 7in. long between faces of abutments, the eastern one of which is of mass concrete construction, that on the west bank being of reinforced concrete, relatively shallow in depth.

Before construction of the main piers started a test H pile was driven to refusal at a depth of 210ft. below cut-off, the last 30ft. requiring an average of 100 blows per foot of penetration from a 7000-lb. double-acting steam hammer. On the basis of this test result and other preliminary investigations final designs were prepared. Each pier consists of forty-eight piles, each a 12in. by 12in. H section, weighing 53 lb. per foot, supplied in 70ft. lengths, and rolled of copper bearing steel made to special C.N.R. standard specification to minimise corrosion. On account of the recorded penetration of the last 30ft. of the test pile it was decided that it was unnecessary to drive the pier piles to the full depth possible; average penetration for the two piers was therefore 175ft. and 145ft. below cut-off respectively. Splices to give these depths were formed by steel plates bolted in place, of sufficient area to develop the full strength of each pile.

The design load for each pile was restricted to 30 tons, and although this is a relatively low value the action of the steel piles as laterally unsupported columns had to be carefully considered. Bracing below water level was not practicable, but investigation showed that by relying on the skin friction developed by the relatively large surface area of the H-section piles in the material immediately below the ground surface, and on the fixity provided by the cross bracing above the water, the unsupported length of the piles would be well below the limits adhered to in standard structural design practice. The bracing between water level and the caps of the pile clusters consisted of 6in. by 4in. by ½in. steel angles electrically welded to the steel piles. The caps are formed of 15in., 33·9-lb. steel channels, also welded to the piles, on which rest the steel grillages supporting the end members of the truss spans. Temporary jigs were used to hold the piles in position while bracing and cap channels were welded in place. All field welding was carried out in accordance with the most advanced practice, special care being taken

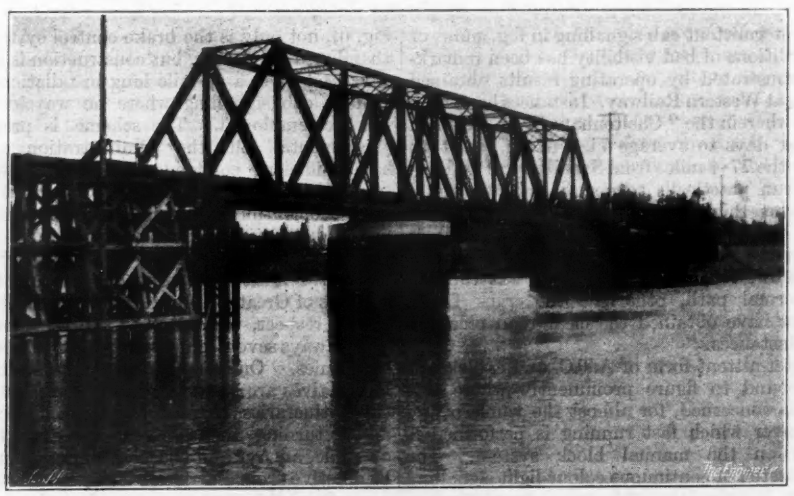


FIG. 2—LAKE LEMOYNE BRIDGE

to keep internal cooling stresses to a minimum. As the Kinojevis River is used for logging, a steel sheet pile protection shield was driven completely around each pier. One was filled with concrete, but the other was not filled, being welded to the steel H piles by means of steel angle connections.

The entire superstructure was erected and steel bracing grillages and caps were welded in place by the Canadian National Railways' own forces in slightly over two months. Since completion the bridge has given great satisfaction. No settlement of the piers has been observed. They do not sway under the passage of trains, exhibiting all the rigidity that is desired. The total cost of the bridge was about 125,000 dollars; estimates showed that a cantilever structure built to conform to the foundation conditions at the site would have cost at least 500,000 dollars.

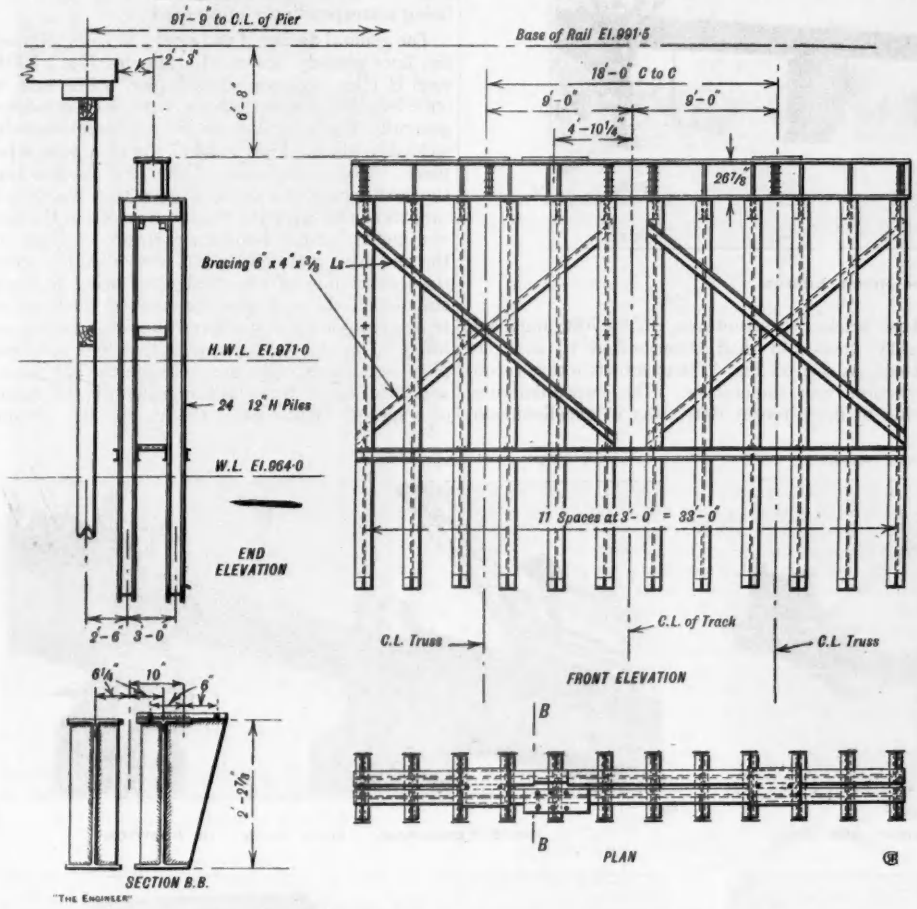


FIG. 3—STEEL PILE PIER OF LAKE LEMOYNE BRIDGE

LAKE LEMOYNE BRIDGE

Another bridge on the same Rouyn-Senneterre branch line, across Lake Lemoyne Narrows, consists of a 235ft. through truss bobtail swing span, two 90ft. through girder spans, and two permanent trestles—that on the west bank being 250ft. long and that on the east bank 370ft. long. The pivot pier for the swing span is of mass concrete, carried to rock at a depth of about 85ft. inside a double wall steel pile cofferdam. The three flanking piers, however, are all of the steel pile welded type, similar to that evolved for the Kinojevis River bridge. Figs. 2 and 3 show this application of the steel pile pier design.

PORTNEUF BRIDGE

A particularly interesting example of its use was in connection with the reconstruction of the C.N.R. bridge at Portneuf, on the line between Montreal and Quebec, which was washed out (together with that of the adjacent C.P.R. track) in a disastrous storm in September, 1938. Traffic was restored over the wash-out within eight days of the storm, by means of a temporary timber trestle. Permanent reconstruction was carried out in the early weeks of 1939 and completed before the annual spring flood on the Portneuf River. The new permanent structure consists of two new steel pile piers topped with welded grill-

FIG. 5—OLD BRICKWORK PIERS AND NEW STEEL PILE PIER

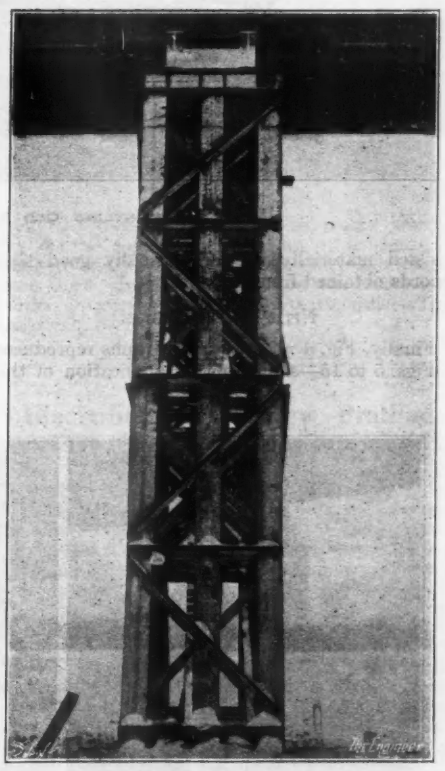


FIG. 6—STEEL PILE PIER

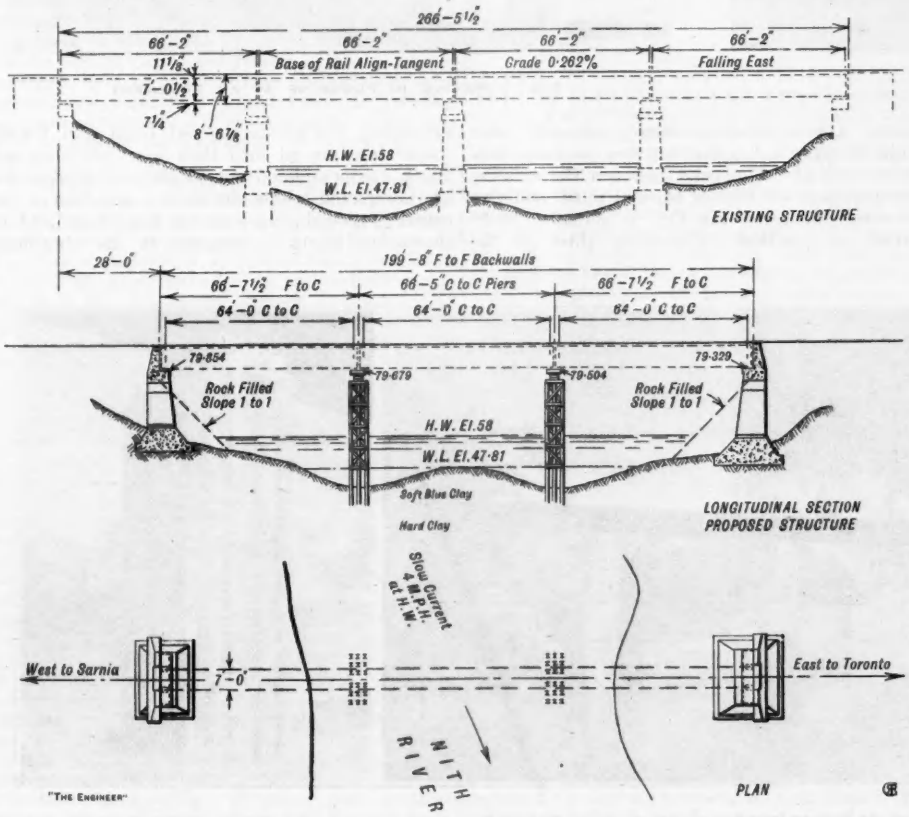


FIG. 4—ORIGINAL AND RECONSTRUCTED NITH RIVER BRIDGE

ages and one new steel pile abutment, the original western abutment and the western pier having been left intact at the time of the wash-out. The superstructure consists of two 50ft., one 60ft., and one 75ft. deck girder spans. With the exception of the 60ft. span, all these steel spans were salvaged from the river bed, repaired at the site, and then placed in position on the reconstructed sub-structure. All work was carried out by C.N.R. forces, and the use of the new type of pier structure unusual pier design—to the reconstruction, under traffic, of the Nith River bridge in South-Western Ontario. The old bridge—Fig. 7—consisted of four deck plate girder spans, each of 66ft. 2in. span, supported on brickwork piles and abutments.

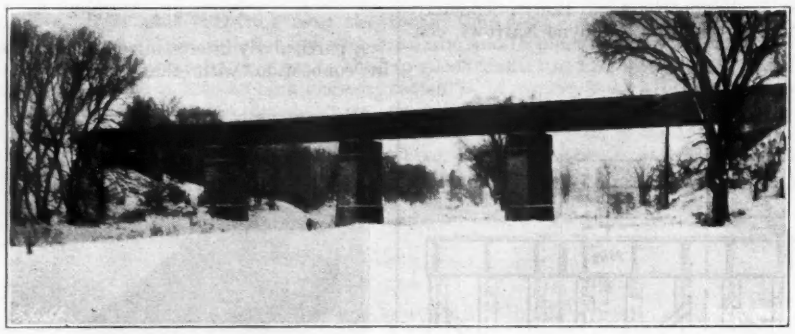


FIG. 7—ORIGINAL NITH RIVER BRIDGE

These brickwork structures, about 70ft. high and eighty years old, had deteriorated to such an extent, as seen in Fig. 5, that sub-structure reconstruction was imperative. The superstructure, being of more recent date, was in excellent condition. The method eventually adopted, after careful study, was to construct two concrete abutments, each about midway between the existing abutment and the first of the old piers, and two new steel pile piers—see Fig. 5—similarly intermediate in position. Thereafter three of the existing four spans were lifted on to the new substructure, the fourth span being removed, filling being carried out to the new abutments to complete the reconstructed river crossing. By the adoption of this ingenious scheme a great saving in cost was effected over the more usual methods of reconstruction, and traffic interference was reduced to a minimum. The use of steel pile piers contributed greatly to this economy by obviating the need for falsework in the river, obstruction to the river flow being correspondingly minimised.

The general design of the steel pile piers followed the lines already described, 12in. by 12in., 53-lb. steel H piles, eighteen to each pier, being used, in 60ft. lengths. Bracing above water level consisted generally of 4in. by 4in. by $\frac{3}{8}$in. angles, electrically welded in place. Figs. 6 and 15 show the completed piers. After completion of the new substructure the next operation was the construction of a temporary trestle to carry the track out to one of the new abutments, and a temporary trestle support for the end span, parallel to, but some distance from, the centre line of the bridge. During a week-end period the end span was moved sideways on to the temporary support and the second span was lifted on to the new abutment and first steel pile pier—see Fig. 8. The gap between the old second and third spans was closed temporarily by means of a special "half-span," seen in Fig. 9. During succeeding week-ends the old third and fourth spans were moved into their new positions and filling was completed out to the new abutments. The completed bridge, during the operation of dismantling the old piers, is seen in Fig. 10, and Fig. 11 shows the filling in progress at one abutment.

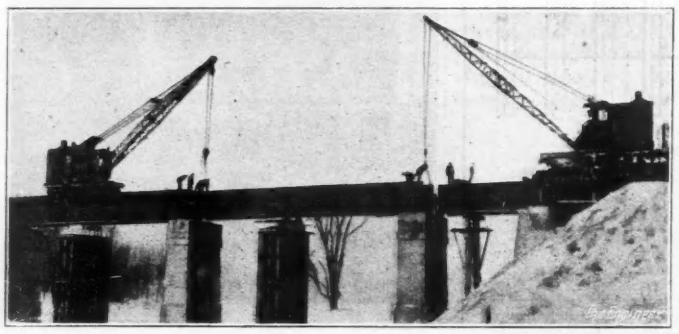


FIG. 8—MOVING END SPAN ON TO NEW ABUTMENT AND PIER

FIG. 9—TEMPORARY "HALF-SPAN" IN POSITION

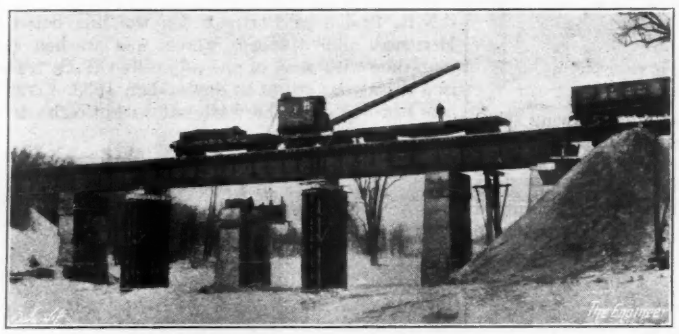


FIG. 10—DISMANTLING OLD PIERS

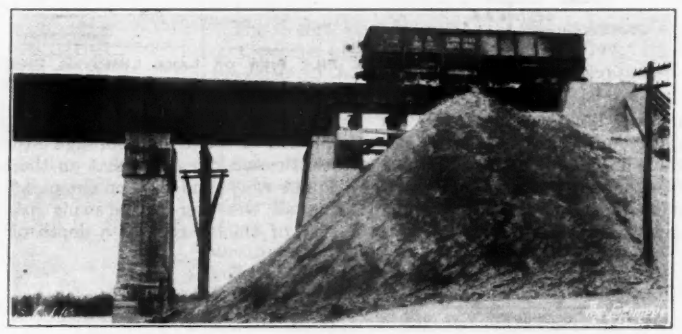
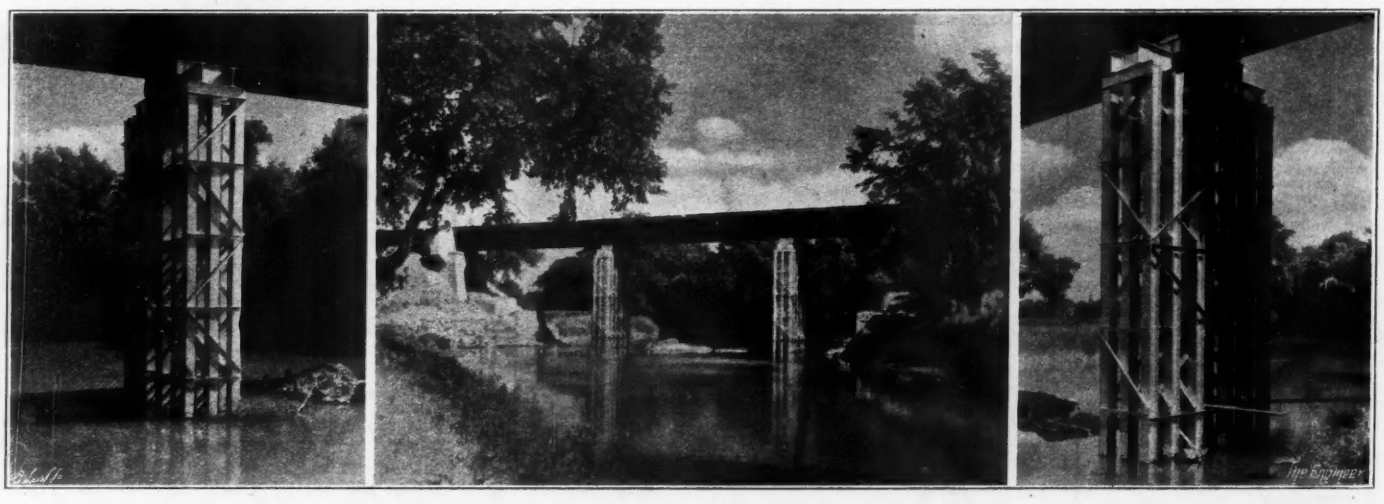


FIG. 11—FILLING IN PROGRESS AT AN ABUTMENT

assisted materially in the unusually good time records obtained from the work.

NITH RIVER BRIDGE

Finally, Fig. 4 and the photographs reproduced—Figs. 5 to 15—show another application of this



FIGS. 12, 13 AND 14—RECONSTRUCTED NITH RIVER BRIDGE

Figs. 12, 13, 14 show the finished structure, the steel pile piers finished in aluminium paint, their unusual design harmonising well with the beautiful sylvan setting in which the bridge is here seen.

The information herein presented was kindly supplied by Mr. Charles P. Disney, Bridge Engineer,

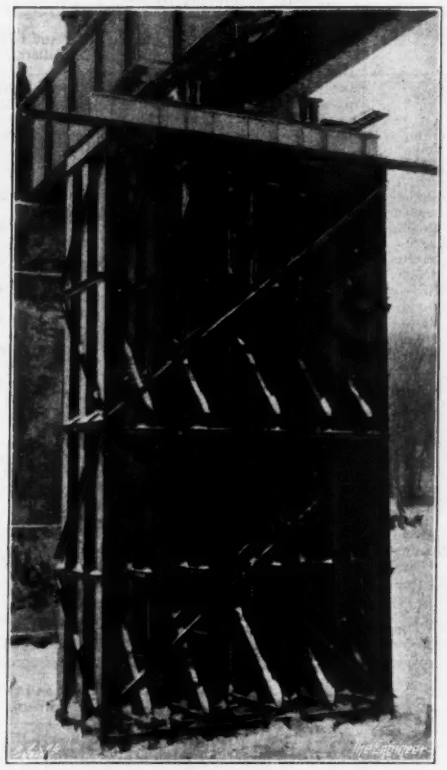


FIG. 15—STEEL PILE PIER

Canadian National Railways, Central Region; Mr. Barton Wheelwright is Chief Engineer and Mr. F. L. C. Bond the General Manager.

Asbestos Cement Materials in Building Construction

THE shortage of timber and the need for economy in the use of steel in construction have imposed serious limitations on building enterprise, and it has become necessary to give serious consideration to the utilisation of alternative materials. In order to minimise or eliminate the use of timber and steel the Turners Asbestos Cement Company, of Trafford Park, Manchester, has, in collaboration with the Department of Scientific and Industrial Research, prepared a series of designs of typical structures in which the firm's standard asbestos-cement tubular beams and purlins, sheets, and other materials may be used. These products are non-inflammable, non-corrosive, and require no painting or other treatment for preservation, whilst the sheeting and panels are supplied in a wide range of colours.

A typical application of corrugated roof and flat ceiling sheets fixed directly on top of tubular purlins, which dispenses with the necessity of timber or other fixing battens and noggings, is shown in Fig. 1 as applied to a 19ft. span hut. The combination of sheets provides an enclosed air space, and it is stated that the thermal conductivity is about 0·57 B.Th.U. per square foot per hour for 1 deg. Fah. difference in temperature. Over the 4in. diameter purlins is laid ¼in. thick flat asbestos-cement sheeting, in standard sizes, lapped approximately 6in. at each purlin and having butt vertical joints between. These sheets are secured to the purlins by short hook bolts, there being two bolts to each sheet, spaced under the corrugations of the roofing sheets. The corrugated roofing sheets over the ceiling sheets are laid with 2in. side lap and a minimum of 6in. horizontal lap and secured to the purlins by $\frac{5}{16}$in. galvanised hook bolts, which also pass through the lower sheets. Centrally between each pair of purlins and in the corrugation adjoining both sides of the butt joints of the ceiling sheets are fixed $\frac{5}{16}$in. diameter seam bolts. The apex of the roof is formed with specially formed interlocking sheets. The purlins are fixed to the roof trusses by wrought iron U-shaped straps, held by screws or bolted on to the trusses, which may be of steel or timber. The purlins are supplied in standard lengths and are joined together by solid cylindrical dowels which fit tightly into the tubes and project about 12in. into each of the ends.

Another design—Fig. 2—shows the method whereby asbestos-cement tubing may be used for a roof truss member or rafters. In this 24ft. roof span, 6in. inside diameter truss rafters are spaced at 10ft. intervals and 3in. diameter tubular purlins are used. In such a design the weight of metal used, including the reinforcement in the eaves, apex, and purling connectors, and the rods, is 39 lb. per truss. The relatively light weight of the various members enables them to be man-handled on the site, without necessity for hoisting and erecting plant.

Where the trusses are set upon brick or similar walls or piers, a ¾in. diameter iron dowel is set 4½in.

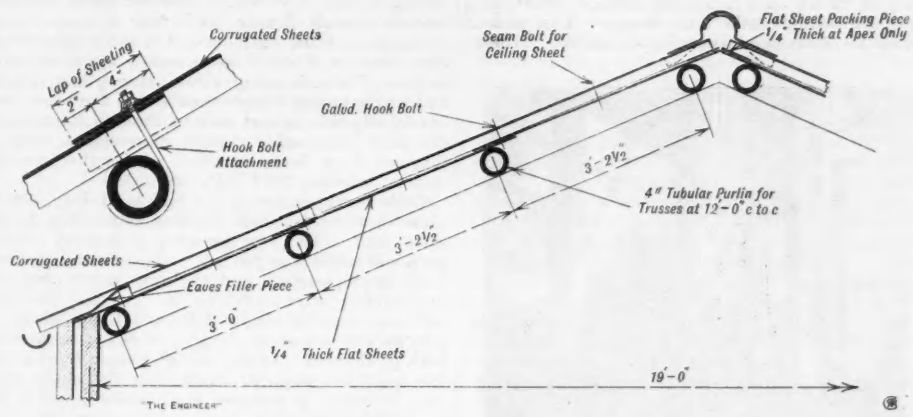


FIG. 1—DESIGN FOR A 19-FOOT SPAN ROOF

from the inside of the wall in line with the centre of the truss and projecting 2in. above the top of the wall. These dowels serve to position reinforced concrete sockets which are set at the foot of each truss and are afterwards built into the wall. One form of foot is shown in Fig. 2, and from this may be seen the manner in which the tie bars pass through on the same centre line as the trusses and are secured by nuts on the outside face of the wall under the gutter. Similarly, the trusses are held together at the apex by a reinforced concrete connector through

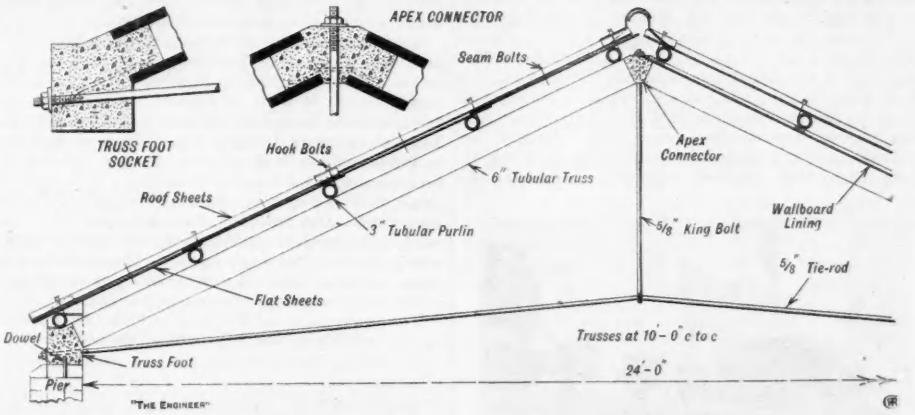


FIG. 2—DESIGN FOR A ROOF TRUSS MEMBER

which the king bolts pass. At both the apex connectors and the foot members the trusses are firmly held by spigots, which pass for a short distance into the tube, and the tie bars hold the component members into a rigid assembly. The purlins are fixed to the trusses by special reinforced concrete connectors, each consisting of a body with a convex base which seats upon the truss and is held in position by a dowel projecting from the base and passing through the truss. These connectors are made with either one projecting spigot, to register in the end

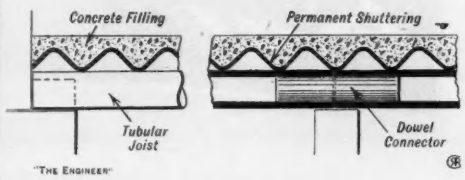


FIG. 3—DESIGN FOR SUSPENDED FLOOR

of a purlin at the end of the building, or with spigots projecting from opposite sides, to register in the ends of purlins meeting at a truss. The roof and ceiling sheets are assembled in a similar manner to that described for the hut roof.

In the construction of open-frame buildings tubular stanchions or uprights of asbestos-cement, set in concrete footings, can be used and the above described types of roofs used in conjunction with them.

In Fig. 3 may be seen the design which has been prepared for the construction of a suspended floor on sleeper walls in which asbestos-cement tubular beams are used as joists to support corrugated shuttering upon which cement is laid.

The joists are bedded in the sleeper walls, the lengths being joined up by dowel connectors which are preferably arranged over the intermediate beams. These dowels not only line up the joists, but ensure the development of full strength and spread crushing stresses at the ends. Asbestos-cement corrugated sheeting for permanent shuttering is laid, rough surface uppermost, with 2in. side laps and approximately 6in. end laps, and mitred at the corners.

To hold the shuttering in position the sheets are held firmly by two $\frac{5}{16}$in. stirrup straps at the end lap. After being brushed clean and sprayed with water the shuttering is ready for the application of the concrete filling, which should be levelled to a depth of 1in. above the highest point of the sheets.

Where it is required to construct upper floors the above design may be used by substituting supporting beams for sleeper walls, but for this type of floor the Turner Asbestos Cement Company has developed a form of bridging block for use in conjunction with reinforced concrete joists. These blocks are laid dry on the supporting joists, no other shuttering being necessary, and the concrete filling laid directly upon them. Supplied in standard 6ft. lengths, the blocks are easily cut into shorter lengths with a hacksaw.

Electrification of New Pralhad Mills, Bombay

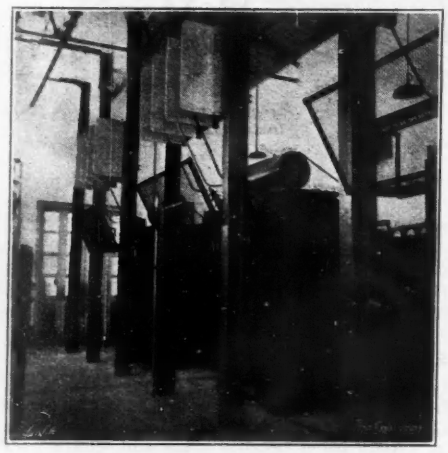
THE New Pralhad mills, Bombay, has recently been completely electrified. The contract was entrusted to Crompton Parkinson, Ltd., of Bush House, London, W.C.2. This mill has 31,500 spindles and 963 looms. In addition to the preparatory, spinning, and weaving departments, the mill has a large dyeing, bleaching, and finishing section, the range of products covering longcloth, dhoties, saris, and cotton blankets.

Until the end of 1939 power was supplied by a Hick-Hargreaves two-cylinder horizontal cross-compound steam engine fitted with Corliss valves. It was built in 1902, and then had cylinders 30in. and 56in. diameter by 5ft. stroke, developing 1430 I.H.P. as a full economical load at 63 r.p.m., with a boiler pressure of 125 lb. per square inch. At a later date a new low-pressure cylinder was fitted, having a bore of 58in., and by making use of its overload capacity, the engine was finally developing about 1700 H.P. By July, 1938, additional machinery in the mill had increased the load on the engine to the maximum with which it could deal, and since various developments were planned it became necessary to provide additional power.

A considerable amount of process steam is required,

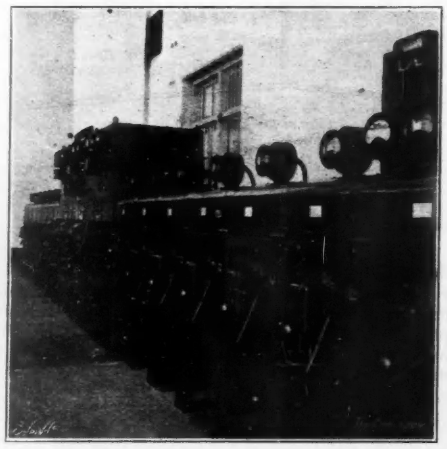
and the original proposal was to provide electric drive for the looms, dyeing, bleaching, and folding departments, amounting to about 1000 H.P., leaving the carding, roving, and spinning departments to be driven by the steam engine. Further consideration showed that it would not be economical to convert only part of the mill, and a scheme was drawn up for complete electrification. The boilers have been retained to produce process steam, although firing has been changed from coal to oil, while the engine has, of course, been dismantled.

Power is taken from the Tata Electric Power Company at 22 kV on a maximum demand tariff and a two-part sliding scale unit charge. The present demand is about 4½ million units per annum. An order



SUBSTATION BUS-BARS AND ISOLATORS

was placed with Crompton Parkinson, Ltd., at the end of February, 1939, for the whole of the work, including substation equipment, cables, motors, control gear, mechanical drives, and power factor correction equipment. It was naturally important that the mill should not need to shut down, and it was therefore a condition of the contract that the changeover should be carried out without interfering with production. In some of the departments the scheme adopted was influenced by this consideration. The majority of the departments retain the original line shaft drive, but in most cases subdivision has reduced the total horsepower on each shaft. The calendering and mixing departments have been arranged for individual electric drive to each machine, and the air compressors are similarly driven. Although the



MAIN LOW-TENSION SWITCHBOARD

scheme includes six motors of 175 H.P. which could conveniently have been supplied at 2200 volts, distribution is at 400 volts throughout, because any future extensions will be more easily dealt with at this voltage. In addition, a single-voltage system gives greater flexibility and enables 50 per cent. transformer standby capacity to be provided without installing more than three transformers. The capital cost of standby capacity is of importance where the site limits the ultimate capacity of extensions.

The substation is equipped with three 1000-kVA B.E.T. 22,000/400-volt transformers, supply being taken from the supply company's circuit breakers to an overhead bus-bar system and air-break isolating switches. The whole of the low-tension equipment is ironclad, and the transformers are connected to their low-tension cubicles by two single-core 1 square inch paper-insulated lead-covered cables per phase. The main low-tension switchboard comprises seventeen units, *i.e.*, three transformer cubicles, three "Klad A" units controlling 850 kVA of condensers, ten "Klad A" units controlling outgoing feeders, and one "Klad A" unit with separate metering for the lighting system.

Nearly 2 miles of cable were laid to connect the substation to the distribution boards in the various departments, and as cable laying had to be carried out in July and August, usually the wettest months of the monsoon, it was fortunate that last year the rainfall was much below the average, giving very little trouble as a result of flooding of the trenches.

Line shafts are driven by screen-protected or pipe ventilated motors, depending on their situation, and for motors up to 40 H.P. "Tork" pattern machines are employed. The twenty-nine cross shafts in the loom sheds are each driven by one motor, 19–20 H.P. and 10–16 H.P. motors being installed. The four calenders are driven by variable-speed slip-ring motors through Fenner "V" rope drives, and are operated by drum controllers. The three compressors have similar drives from constant speed slip-ring motors. The main group drives in the carding, raising, and ring spinning departments and in the blow-room are by slip-ring motors driving through Renold and Coventry bush roller chains, of which a total of fifty-one have been installed. Altogether seventy motors, totalling 2600 H.P., are installed.

Cable laying began in the middle of July, alterations to the substation building proceeding at the same time. The transformers, substation switchgear, and cables were put into commission by the third week in September, and the first motor was run immediately after switching in. At that time the mill was working single shift, and the majority of motors were installed at night, so as not to interfere with production. At no time were more than a very few machines stopped. Soon after the outbreak of war, increased production was obtained, which had been impossible with steam engine drive, owing to the very uneconomical conditions when operating the engine at light load.

G.W.R. Railcar Tests

THE first of twenty new oil-engined railcars, built by the Associated Equipment Company, Ltd., of Southall, will shortly be placed in service by the Great Western Railway. These vehicles were fully illustrated and described in our issues of May 17th and May 24th, but we have now to hand particulars of test runs, from which we give below the figures for average start-to-stop speeds and fuel consumption under different conditions of loading.

Tests were conducted for six days on the G.W.R. line from Southall to Westbury, a return trip of 173 miles. From Southall to Newbury the line is practically level; it then rises gently to Bedwyn, where the gradients become steeper to Savernake Summit. The line drops to Pewsey, and is then up and down to Patney, where it drops fairly steeply to Lavington, including about 4 miles at 1 in 222. The tests were made with railcar No. 19, a vehicle embodying dual gear ratios, and both low and high gear ratios were used in the trials in combination with a single trailing coach and two trailing coaches. Particularly interesting are the figures for ton-miles per gallon given in the table relating to fuel consumption.

The appearance of the new vehicles is illustrated in the accompanying engravings, showing two cars

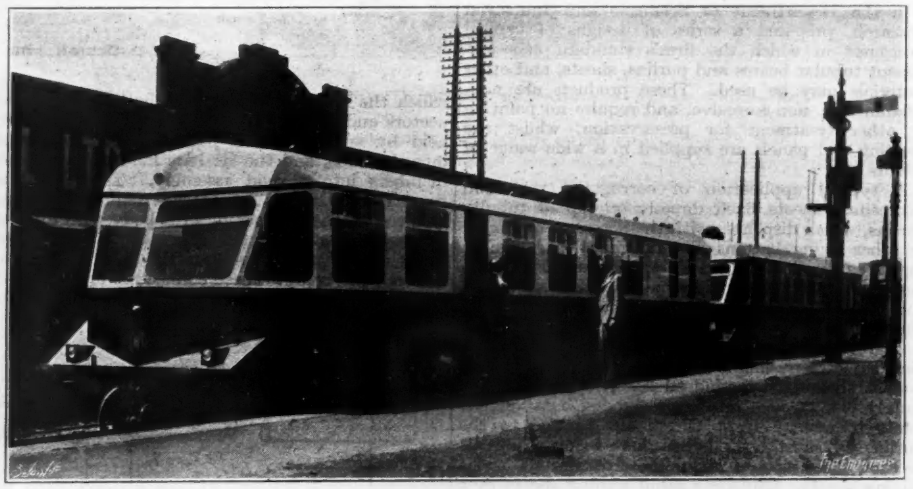
Average Start-to-Stop Speeds

	Distance, miles.	Car only.		Car and one trailer.		Car and two trailers.	
		Low ratio, m.p.h.	High ratio, m.p.h.	Low ratio, m.p.h.	High ratio, m.p.h.	Low ratio, m.p.h.	High ratio, m.p.h.
Outward trip—							
Southall to Slough ...	9½	35·8	49·5	38·6	38·0	33·5	36·2
Slough to Reading	17½	43·8	56·1	39·0	42·8	35·0	36·8
Reading to Newbury	17	35·2	49·8	38·8	38·4	32·4	35·2
Newbury to Bedwyn...	13½	42·0	50·5	39·6	39·6	33·7	34·4
Bedwyn to Patney ...	14½	41·5	48·3	38·7	43·5	32·8	37·4
Patney to Westbury	14½	42·9	52·7	41·5	45·8	38·6	42·5
Total ...	86½	40·0*	51·3	39·2	41·2	34·2†	36·9
Return trip—							
Westbury to Southall	86½	38·6‡	54·9	42·6	45·1§	38·9	39·6‖
Both trips	173	38·4	53·0	41·0	43·0	36·4	38·3

All outward trips had permanent way check to 15 m.p.h. on Reading to Newbury section, lasting about 1½ min.
* Three signal checks, totalling 5 min.
† One signal check, totalling 1½ min.
‡ Three signal checks, totalling 13½ min.
§ Three signal checks, totalling 3½ min.
‖ Three signal checks, totalling 2 min.

Fuel Consumption

	Car only.		Car and one trailer.		Car and two trailers.	
	Low ratio.	High ratio.	Low ratio.	High ratio.	Low ratio.	High ratio.
Consumption, m.p.g.	7·0	6·6	5·23	5·85	4·95	4·86
Total weight unladen, tons ...	35·6	35·6	68·9	68·9	102·2	102·2
Ton-miles per gallon	249	235	360	403	505	497
Average speed per day, m.p.h. ...	38·4	53·0	41·0	43·0	36·4	38·3
Comparison of ton-miles per gallon × speed	1	1·36	1·55	1·81	1·93	1·98



RAILCARS FOR THE GREAT WESTERN RAILWAY

coupled together on trials and the interior of one of the vehicles. Twin-car sets will have intermediate straight ends and vestibule connections. It will be noted that the seats are now arranged in pairs on each side of a central gangway. Of the twenty new vehicles, four will be arranged as twin-coupled units with vestibule connections and will be designed for a maximum speed of more than 70 m.p.h. One car will have a body designed for parcels carrying and the remaining fifteen—with lower speeds, but with greater tractive effort—will be used for local services.

The most apparent difference between the new cars and those now in service is that, although the general outlines have been retained, all curves and rounded surfaces have been replaced by corresponding straight lines and flat panels. This procedure has been extended to the roof, where the former elliptical shape is now made up of a series of flats.

The value of streamlining has only been proved at relatively high speeds. Since nearly all the new cars are intended for relatively slow-speed, branch-line working, it was decided to abandon the original shape. Replacing the downswept, rounded front by framing, which in its lower part is nearly vertical, has resulted in an aggregate gain of 2ft. in the body length of the car to which can be added a further foot obtained by continuing the body for 6in. over the headstocks at each end. The extra 3ft. thus gained have provided additional and useful floor space for passengers and luggage, and have made possible the provision of more commodious driver's cabs. Following the practice instituted with car No. 18, headstocks are now of standard railway pattern, and screw couplings and vacuum brake pipe connections are fitted for use when hauling trailer coaches and other standard rolling stock.

Two saloons are provided in each car, one carrying thirty-two and the other sixteen passengers. They are divided by a vestibule, and between the large saloon and the driver's cab is a luggage compartment approximately 15ft. long. Steel panelling has been used throughout, the panels being secured to light teak framing stiffened with steel inserts. Floor members are in the form of flitched beams with steel

diaphragms connecting them to the body sides and the flooring itself is made up of fireproofed boarding covered with "Insulwood," ¼in. thick, for sound-proofing and insulation. Specially shaped members have been employed to maintain the straight-line appearance of the roof and to provide curved ceilings in the interior.

An oil-fired, automatic steam generator, of the Vapor-Clarkson type, made by Gresham and Craven, Ltd., provides heating sufficient for the car itself and

INTERIOR OF RAILCAR

any trailer coaches that may be attached. With this system steam is available within a few seconds of starting up. Oil is supplied from a tank mounted on the underframe, and water from a tank carried near the generator, housed in the luggage compartment.

Higher Pressures in Industrial Plants*

By WILLIAM F. RYAN†

PUBLISHED records and other sources of information disclose only 85 plants now operating in the United States supplying power *and* steam to industries in which the throttle pressure is 500 lb. per square inch or higher. This number includes six installations owned and operated by public utilities. The data on which this survey is based are drawn from these 85 plants and while no claim is made for completeness, it is believed that practically all of the major installations are included. The 85 plants reviewed have a combined power generating capacity of 836,875 kW, of which 284,000 kW is operated by public utilities and 552,875 kW by manufacturing concerns. Of the 136 prime movers, 108 operate at throttle pressures between 500 lb. and 750 lb. per square inch, but more than 25 per cent. of the installed capacity operates at pressures above 1200 lb. per square inch. Table I shows the number and capacity of units for various pressure ranges.

TABLE I.

Throttle pressure, lb. per sq. in.	No. of prime movers.	Combined capacity, kW.
500–599	21	78,525
600–749	87	439,400
750–899	14	86,500
900–1199	0	0
1200–1600	11	209,450
Over 1600	3	23,000
	136	836,875

There is no "trend" of pressure with respect to time. The highest pressure installation included in this group (Diamond Alkali Company, Painesville, Ohio: throttle pressure, 2000 lb. per square inch) started operation in 1939, but the only other plant (the Philip Carey Manufacturing Co., Lockland, Ohio; throttle pressure, 1650 lb. per square inch) operating at a pressure above 1600 lb. per square inch dates from 1931. The majority of plants in the 1200 lb. to 1600 lb. per square inch class have been completed since 1935, and five of the ten plants in this pressure range are operated by public utilities. Pressure is not a function of ownership, however, because the largest utility plant (Louisiana Station, Gulf States Utilities Company, Baton Rouge, La.) in the group operates at a throttle pressure of only 600 lb. per square inch, and the two highest pressure plants, just mentioned, are owned and operated by manufacturing concerns.

No generalisations can be made about the "best" or the "ideal" pressure for plants supplying industrial steam. For condensing turbines in utility plants, it may well be argued that in localities affording moderately priced fuel and abundant circulating water, there is no profit in throttle pressures above 900 lb. per square inch. In the industrial plant, however, it may be economical to use the highest pressures commercially available if the electric power demand is high in proportion to the steam required for process, and if load factor and other conditions are favourable.

In many industrial plant designs the question of pressure has been approached from the wrong angle. In order to generate more by-product power in a given situation, process pressures have been limited or even reduced when greater overall savings might have been made by exactly the opposite procedure. In some heat applications, particularly evaporative processes, high saturated steam temperature is quite as valuable as it is for power generation.

The use of high pressures for process work is a field in which some industries may make savings greater than any that are conceivable in connection with power generation. For the ultimate development of high pressures in industrial work, steam utilisation and power generation must be treated as a joint problem, the objective being to secure the lowest overall-manufacturing costs, rather than the lowest cost or highest yield of electric power.

TEMPERATURE

Table II shows the number of units and capacity included in different ranges of throttle temperature.

TABLE II.

Throttle temperature, deg. Fah.	No. of units.	Combined capacity, kW.
Under 600	1	10,000
600–649	6	12,250
650–699	8	31,000
700–749	57	310,775
750–799	47	211,100
800–849	9	71,000
850–899	0	0
900 and over	8	190,750
	136	836,875

More than half of the units having 42 per cent. of the total capacity operate at temperatures below 750 deg. Fah. The author believes that the problem of temperature in industrial power applications has not been correctly approached in many cases, and that some of the existing installations might have achieved equal results at less cost by using lower pressure and higher temperature.

The effect of throttle temperature on the water rate of back pressure turbines is sufficiently well understood. For example, with 100 lb. per square inch back pressure, as much by-product power per unit of process steam can be generated with 550 lb. per square inch and 750 deg. Fah. at the throttle as with 700 lb. per square inch and 675 deg. Fah. The lower-pressure, higher-temperature steam, however, has a higher enthalpy, and it has been incorrectly assumed that a plant designed for those conditions would necessarily consume more fuel per unit of output. Also the exhaust from the prime mover would be highly superheated and in many processes superheat is of no value. However, if a thoroughfare desuperheating heater is installed in the exhaust to remove the surplus superheat and transmit it to the boiler feed water, the fuel consumptions for the two steam conditions would be identical, but the lower-pressure installation should show an appreciably lower capital cost, and slightly lower expense for auxiliary power, maintenance and perhaps for feed water treatment.

PRIME MOVER CHARACTERISTICS

Seventy-three per cent. of the units included in this survey are back-pressure machines. The remaining 27 per cent., having 38 per cent. of the total capacity, are equipped with condensers. These condensers are usually small, in some instances designed for less than 15 per cent. of the maximum throttle flow.

Table III shows the number and capacity of units for various ranges of back pressure:—

TABLE III.

Back pressure, lb. per sq. in.	No. of units.	Total capacity, kW.
Vacuum	37	317,750
Atmospheric to 15	7	22,500
16 to 25	4	18,000
26 to 50	9	43,000
51 to 100	6	25,000
101 to 200	64	340,425
Over 200	9	70,200
	136	836,875

Of the condensing machines, only one 500-kW unit is non-extraction. The latter, however, operates in parallel with a larger machine exhausting at 40 lb. per square inch and the two units in this plant are therefore the equivalent of a condensing extraction machine. One large unit now under construction, which may operate at a pressure of 500 lb. per square inch or more, is a straight condensing machine with extraction only for feed-water heating.

Extraction pressures range from 5 lb. to 400 lb. per square inch. Thirty-eight turbines are arranged for single extraction, fifteen for extraction at two pressures, and one is a mixed-pressure dual-extraction machine.

STEAM GENERATING EQUIPMENT

Many of the high-pressure installations designed between 1928 and 1933 followed the more conservative design of earlier low-pressure boilers, but all of the more recent installations for which data are available have rates of heat transfer which would have been considered excessive fifteen years ago, although they are lower than current central station practice. Sixteen recently installed industrial boilers, operating at 600 lb. to 850 lb. per square inch pressure and ranging in capacity from 65,000 lb. to 500,000 lb. per hour, show a weighted average heat input of 9200 B.Th.U. per square foot of total surface, including boilers, water walls, and economisers. The corresponding figure is 16,000 B.Th.U. per square foot for six utility plant boilers, operating in the same pressure range, with individual capacities of 140,000 lb. to 575,000 lb. per hour, but with the same total capacity as the sixteen industrial boilers. The lower average rate of heat input for the industrial boilers is due chiefly to the general use of treated water for boiler feed, and the higher concentration of solids in the circulating system.

Except for a greater liberality of heating surface, steam generating equipment, including auxiliaries, fuels, and firing methods, shows no marked difference from current central station practice.

BOILER FEED WATER

It was recognised in 1925 that the boiler feed water supply would be a serious problem in high-pressure industrial plants on account of the large percentage of make-up usually required. Tremendous progress has been made in the art of boiler feed-water purification, but it is still the major problem for high-pressure industrial work where condensate is not returned from the process. The claim is made that any natural fresh water can be chemically treated for any boiler conditions. While this statement may be technically true, its realisation may require large expenditures for equipment and always requires an advanced operating technique to maintain satisfactory results when poor water is treated for high pressures.

The highest-pressure boiler in the group is fed with treated water, but ten of the twelve plants operating at pressures above 1200 lb. per square inch use condensate exclusively. The energy loss which results from the use of evaporative condensers is less than is commonly supposed, and the cost of evaporators is partly offset by savings in cost of steam generating equipment, due to the possibility of using less heating surface and smaller drums, when pure feed water can be assured.

OPERATING RESULTS

In the discussion fifteen years ago pessimism was frankly expressed regarding the ability of industrial operating personnel to handle high-pressure equipment. Experience has proved these fears unfounded, and such difficulties as have arisen have been with equipment, water, and fuel rather than with men.

A few installations have been disappointing with respect to yield of by-product power and overall costs, and several have failed to develop the design capacity, but the majority have shown high thermal efficiency and high availability when operated within their actual capacity. The term "actual capacity" is used in contradistinction to the design capacity or manufacturers' ratings. In Table IV the composite results for six plants indicate the availability and efficiency obtainable in well-designed, competently operated plants.

The plants included in Table IV are not hand-picked to show favourable results, but include all of the plants for which the author had sufficient information to compute availability factors and efficiency. It will be noted that the availability of boilers and prime movers is not far different from the corresponding figures published by the Edison Electric Institute for high-pressure utility plants. Oddly enough, the general average is lowered appreciably by the one plant which has reserve capacity, and in which plenty of time was available for inspection and repairs.

TABLE IV.

Total installed capacity—	
Boilers, lb. per hour	2,535,000
Generators, kW (name-plate rating)	77,500
Total number of prime movers	13
Total number of boilers	14
Total generation for twelve months—	
Steam, lb.	14,836,966,000
Power, kW per hour	458,275,250
Total of individual maximum demands—	
Steam, lb. per hour	2,294,000
Steam, per cent. rated capacity	91
Power, kW	76,970
Power, per cent. rated capacity	99
Load and capacity factors—	
Ratio, average output to maximum demand:	
Steam	74
Power	68
Ratio, average output to rated capacity:	
Steam	67
Power	68
Availability—	
Total outage, all prime movers, hours	12,807
Average outage per unit, hours	986
Average availability of prime movers per cent.	89
Total outage, all boilers, hours	16,329
Average outage per boiler, hours	1,166
Average boiler availability, per cent.	87
Overall thermal efficiency—	
Total net output as power, kW per hour	379,429,000
Heat equivalent of net power output, million B.Th.U.	1,296,000
Total net output as process steam, lb.	11,758,644,000
Heat equivalent of net steam output above heat in returns and make-up water, million B.Th.U.	11,160,000
Total net output, million B.Th.U.	12,456,000
Total fuel consumption, million B.Th.U.	16,426,000
Overall thermal efficiency, per cent.	76
Average heat consumption for power generation only, B.Th.U. per net kWh	4,780
Yield of by-product power—	
Gross kWh per 1000 lb. steam generated	31
Net kWh per 1000 lb. steam delivered	32

* From a paper presented at the Spring Meeting of the A.S.M.E.

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A GRIEVOUS NECESSITY

SINCE our last issue went to press one of the questions that was on everybody's lips has been answered. The French Navy no longer exists as a potential unit of danger to this country. Its major ships have been surrendered, taken, or destroyed, and many of its minor vessels, including submarines, are in British ports. The exact position is not yet known, or has not been revealed to the public. An important part of the Fleet, including the battle cruiser "Dunkerque," was destroyed at Oran, another part has been put out of service at Alexandria; other vessels are in Britain or in foreign ports or on the high seas. The "Richelieu," sister to the "Jean Bart" and "Clemenceau," 35,000 tons, was attacked and put out of action at Dakar on Tuesday last. Some ships, it is not yet known how many, are in Toulon, and others in Brest, including the unfinished battleship "Clemenceau." One of the former is the "Strasbourg," sister to the "Dunkerque," which escaped from Oran. She was subsequently struck by an aerial torpedo, but is believed to have reached Toulon. Other French ships are at sea or in French harbours oversea. Steps to deal with them are being taken. It is unlikely that more than a very few will be able to surrender themselves to Germany.

As we have said, the position is still obscure, but even on a conservative estimate the British naval strength has been augmented by the capture or surrender of many ships, whilst the Germans have been robbed of many which, despite their promises to the contrary, no one doubts they would have employed against Great Britain just when it suited them to do so. According to Mr. Churchill, two battleships—certainly of the "Bretagne" 22,000-ton class—two light cruisers, some submarines, including the "Surcouf" of 4300 tons, the largest submarine in the world and remarkable by possession of a hangar containing a small seaplane, eight destroyers, and numerous small craft were boarded in British ports on July 3rd with trifling resistance. At Alexandria there are one 22,000-ton battleship, four cruisers, three of 10,000 tons, and one of smaller displacement, beside lighter craft. This fleet, outnumbered by a powerful British fleet, is now being completely demilitarised. The remainder of the French Navy, save a few large ships and many smaller ones and submarines, lay at Oran and Mers-el-Kebir, on the shore of Algeria. The eyes of the world had been turned on this important fleet because its commander had been understood to declare that in no circumstances would it be surrendered to Germany. It was therefore believed that the use of force to secure it would not be called for. That hope was grievously disappointed. A powerful British force offered the French three honourable alternatives—to sail with Great Britain against Germany; to be conducted to a British port; to sail to a distant French or American port to be laid up for the duration of the war. If all these alternatives were rejected, the French fleet was called upon to sink itself within six hours. If it refused to do so, then the Navy would have no alternative but to destroy it. After day-long parleys, Admiral Gensoul, in command of the French fleet, announced his intention to fight rather than surrender, and at 5.53 p.m. Admiral Somerville, in command of the British fleet, opened fire. At 7.20 he reported that a battle-cruiser of the "Strasbourg" class—the "Dunkerque"—was damaged and ashore, that a battleship of the "Bretagne" class had been sunk, and a sister ship heavily damaged, and that two destroyers and a seaplane carrier, the "Commandant Teste," were sunk or burning. During this action the "Strasbourg" managed to escape, but was overtaken by an aircraft of the Fleet Air Arm, and was struck by at least one torpedo. She appears to have reached Toulon, probably with other French ships from Algiers. Thus was a large part of the French Navy captured or destroyed within a few hours. Of eight battleships in commission, six were definitely accounted for by July 3rd, and the "Richelieu" on July 7th. Of them all, the "Strasbourg" alone is in a French port, and she is in a damaged condition. On Tuesday Mr. Alexander refused to give any information about the incomplete "Jean Bart" to the House of Commons, and stated that three capital ships of the Bretagne and Courbet classes had passed under our control. Out of seven 10,000-ton cruisers, three are at Alexandria, and of seven light cruisers, two are in British ports and one in Alexandria. The French own over seventy torpedo craft of various displacements, and of them only ten can be definitely accounted for. Of submarines there was a large number, getting on for one hundred. What their fate is we do not know, except that some are in British hands.

In the long annals of the British Navy there is no action more grievous, more heart breaking, and less glorious than that at Oran. The British fleet was not in a position of much danger; it suffered few casualties and little material damage. On the other hand, the French fleet was hopelessly placed. The ships, according to General de Gaulle, "were at their moorings unable to manœuvre or scatter, with officers and crews who had been corroded for a fortnight by the worst moral sufferings. . . . Their destruction was not the result of a battle." In these circumstances, the result was a foregone conclusion, and whilst we have the profoundest respect for the course of honour which Admiral Gensoul decided to take, we cannot but regret profoundly that he did not elect to accept one of the alternatives placed before him, and thus not only save the lives of many Frenchmen, but conserve his ships for that day when the French Navy will arise again. Had he done so, a very melancholy chapter in the history of the war would not have to be written. He forced upon the British Government a grievous decision, from which there was no escape. To allow the French ships to fall into German hands was unthinkable; to capture them in the circumstances was impossible. They had therefore to be destroyed. There was no possible alternative. Deplorable as it was, it had to be done. Let us quote again from General de Gaulle, who, whilst admitting to "grief and anger," acknowledges that Great Britain took a course which was forced upon her. Broadcasting on Monday night, he said: "Speaking to the French people, I ask them to consider things from the only point of view which must count—that of victory and liberation. The Bordeaux Government had agreed to hand over ships to the enemy's discretion. There could not be the slightest doubt that on principle and out of necessity, the enemy would have used them either against Great Britain or against the French Empire, and I say without hesitation that it was better they should have been destroyed. I would rather know that the 'Dunkerque'—our beautiful, our beloved, our powerful 'Dunkerque'—is aground at Oran than see her one day manned by Germans and shelling English ports, or Algiers, Casablanca, or Dakar." The British Government, the British Navy, and the British people could ask for no more generous acknowledgment of the dire necessity which forced upon them a very grievous action than these words of a gallant Frenchman, who throughout all the trials of his country has kept his head high and his resolution firm.

A Fortress of the Air

No one would claim that the whole course of the present war has gone according either to our expectations or our desires. In modern war it is but rarely the expected that happens; we now find ourselves in the position of having to rely mainly—possibly entirely—on our sole strength for the further defence of Allied interests. Our island has become the main fortress against widespread aggression. For many centuries of its history it has been a fortress in the sea. That alone does not now suffice. It has also to be a fortress of the air. With naval vessels we lead both in quantity and quality. But in air fleets, although ahead of the enemy in quality, whether of men or machines, we are still second to them in numbers. This is no accident, for the enemy adopted deliberately the policy of having but few standard types, so as to ensure intensely rapid production. We originally aimed in the main at quality and it was much later that we earnestly set ourselves to the task of producing in huge numbers.

This is a very vital difference in policy, and it raises the question, How far does weight of numbers count in air warfare? From the long experience of the Four Years' War one concluded that numbers mattered little in comparison with fighting quality; a few wolves were more than a match for any number of sheep. The better fighting aircraft, even when outnumbered, could destroy the less efficient fighters, and after that, and even more easily, the then unprotected bombers. How far is that still true? It is largely a question of how long the war lasts. Masses of even medium quality aircraft thrown recklessly into a land battle at a critical phase may, as we have seen, make just the difference between success and failure, for even if the losses of those aircraft are stupendous, the result obtained on the ground may be crucial. But it is essentially a gambler's bid. If it fails, it fails utterly and may even settle the result of an entire campaign; for in a long-drawn-out struggle the high-class fighters will take a much heavier toll of

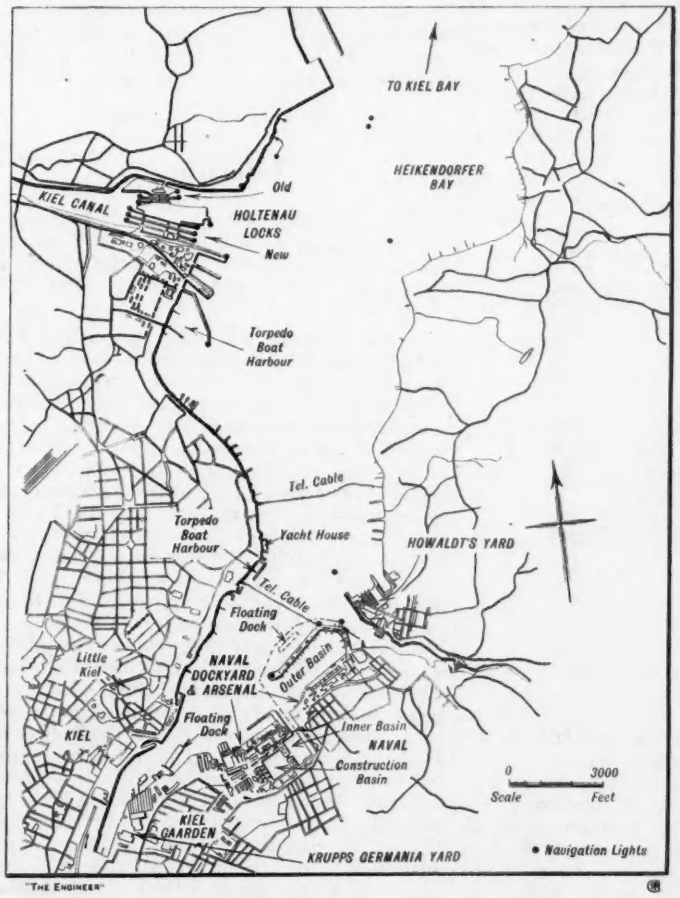
the enemy than their own losses, until the balance of numbers is reversed and then both quality and quantity will be found on the same side; when that happens the war is over. Our island fortress is threatened with invasion both by sea and air. But invasion by sea is no easier in one direction than the other, and if, even with command of the sea, and of the Channel ports on this side, it is plainly difficult for us to invade Western Europe, it must, without that command, be immensely more difficult the other way round; and although "brains" count too, there is no need to assume that the whole of war-staff ability is to be found on the other side of the Channel. Invasion by air is technically simpler, but the prospects of success are slight. Our defences are exceedingly strong and our warning system as near perfection as science can make it. So strong is the defence that daylight attacks may be expected to meet with such losses as soon to bring them to an end. Attacks by night mean great uncertainty as to the whereabouts of the objective, except in the presence of moonlight unhindered by cloud, mist and fog. Moreover, in any condition favourable to attack, defence is also aided. On dark nights it is almost impossible with the present efficient "black-out" for targets to be seen, and a mere distribution of bombs at random has but little bearing on the issue of the war, however much of a general nuisance they may be. Further, with the air speeds of to-day, it is hard, even under favourable conditions, to get an effective aim at a specific defended target. To dive at it increases the accuracy, but is a most risky procedure, since even machine-gun defence is then effective. Whilst high-altitude attack is safer, it means that the bomb will take at least half a minute to fall and hence must be released some three miles away from the target. If one allows an additional quarter of a minute for sighting, that operation must begin four and a-half miles away, so that the target must be identified with certainty when the aircraft is at least five miles off and is viewed at a decidedly oblique angle. Such identification is frequently impossible, however, even under conditions of the best visibility, and although by using slower bombers this difficulty would be diminished, who would care to send slow-speed aircraft on such a task?

The one remaining form of air attack is the use of aircraft for carrying troops, preferably no doubt for a landing on an aerodrome, and failing that by parachute. As the spearhead of a sea attack there may be something to be said for such an attempt, but in the likely event of the sea attack proving unsuccessful, the air attack must end in complete disaster, for the troops so landed must be completely unprovided with artillery capable of meeting that of the defence. Hence all the winning odds are on the side of our island fortress, however long the war may continue, for during the struggle the balance of air strength must gradually turn in our favour, and when that happens the end cannot be far away.

Air Force Targets in Germany

KIEL AND THE KIEL CANAL

ONE of the first air actions of the war was the bombing of the Kiel Canal, early in September, when the entrance locks at Brunsbüttelkoog, on the Elbe, and Holtenau, at the Kiel end of the canal, were partly destroyed. In the last few weeks extended attacks from the air have been directed on to the Kiel area, more especially in connection with the presence at the naval base of the 26,000-ton displacement battleship "Scharnhorst," which, we may recall, was severely damaged by British naval and air forces on June 22nd as she was leaving Trondheim Fiord. It is assumed that the battleship was seeking a safe harbour in order to effect repairs after the successful bombing by machines of the Fleet Air Arm on June 13th. Soon after the battleship left Trondheim Fiord she was sighted by one of our submarines, which immediately attacked and obtained one hit with a torpedo. A little later an attack from the air was delivered by torpedo-bomber aircraft of the Fleet Air Arm; no hits were scored on the damaged battleship, but one of the escorting destroyers was struck by a torpedo. About an hour later a further bombing attack was made on the "Scharnhorst" by R.A.F. aircraft of the Coastal Command. In spite of intense opposition from an escort of some fifty Messerschmitt fighters, three direct hits with heavy bombs were obtained, one full on the stern of the ship, and two alongside No. 1 and No. 2 gun turrets.



MAP OF KIEL HARBOUR

On Monday, July 1st, it was reported that the "Scharnhorst" was lying under repair in a floating dock off the naval arsenal and dockyard at Kiel (see the accompanying map), and that evening aircraft of the Bomber Command left England for an attack. Excellent visibility enabled the raiders to trace their route right up to the Kiel naval dockyard, which the report states was easily located without the assistance of parachute flares. The attack took the defenders by surprise a few minutes before midnight. The first aircraft approached the target at a considerable height, and then with engines throttled back glided down to launch the attack. The first bomb scored a direct hit on the floating dock, about a third of the way along its length, and was quickly followed by others which burst among buildings on the quayside. For nearly an hour the battleship and the dockyard were continuously attacked by successive units of the strong raiding force. Four direct hits on the "Scharnhorst" and the dock were claimed by one aircraft; another, diving down to within 2000ft. of the dock, dropped three of its heaviest bombs, which burst in a row across the battleship, and started fires on the ship and on the edge of the dock. This aircraft made a second run and scored definite hits. A few minutes later the floating dock was again hit by a salvo of bombs, aimed by another aircraft, and five large fires were seen to break out. The crew of a closely following aircraft reported that six hits on the dock had been obtained and that the fires so lit up the target that the outline of the superstructure and the gun turrets of the "Scharnhorst" could be plainly seen. To other aircraft the duty was entrusted of bombing naval buildings belonging to the naval arsenal and the dockyard on the other side of the canal. A large building to the north side of the dock was struck and was set on fire, and another big shed was so completely gutted that the steel girders of its framework were plainly seen from the aircraft overhead. Large fires were also started in other parts of the dockyard.

Items of interest in the accompanying plan are the Holtenau entrance locks to the Kiel Canal which will be seen to the top left of the drawing. The smaller locks are those of the earlier Kaiser William Canal before its widening, which was completed in 1914. The first canal, opened in 1895 by Kaiser William II, was of the following dimensions:—Cross section, 413 square metres; sole breadth, 22 m.; depth, 9 m., with a width between banks of 67 m. When widened the cross section was increased to 862 square metres, with a sole breadth of 44 m. and a depth of 11·3 m., the width between the two banks being increased to 103 m. The locks at both ends of the canal were added to by constructing two larger locks alongside the original smaller locks. The small locks each have a length of 150 m. with a breadth of 25 m. and a depth of 9·57 m. The large new locks have a total length of 330 m. and are each divided by a sliding gate into working lengths of 210 m. and 100 m. in length, thereby facilitating the easier handling of smaller ships. Their breadth is 45 m. and the depth 14 m. The operating machinery is electrically driven, power being taken from overhead lines and also an oil-engine-driven generating station designed for peak load service.

The locks at Brunsbüttelkoog are similar to those at Holtenau. Other interesting features of the canal are the high-level bridges which cross the canal at Rendsburg and at Levensau.

Other important objects shown on the accompanying map in the Kiel Canal area and Kiel itself are the shipbuilding yards of Friedrich Krupp A.G., Germania Yard at Kiel-Gaarden, and the Howaldt shipbuilding yard. Both these concerns have graving docks and floating docks, but none of these docks or those at the naval dockyard is, according to the latest dock returns of Lloyd's Register of Shipping, large enough to dry-dock the "Scharnhorst." Two docks which might possibly be used for such a purpose are Nos. 5 and 6 docks, formerly stationed at the Blohm and Voss yard in Hamburg, which, when fastened together by chains, were used to lift the Cunard White Star Liner "Majestic." These docks have a lifting capacity of 46,000 and 38,000 tons respectively, with lengths of 575ft. and 625ft., and a width of 123ft.

The principal particulars of the "Scharnhorst" are as follows:—Standard displacement, 26,000 tons; length on water line, 741·5ft.; beam, 98·5ft.; mean draught, 24·66ft. The armament of the ship includes nine 11in. guns in triple mountings, twelve 5·9in. guns, and fourteen 4·1in. and sixteen 37 mm. anti-aircraft guns. Four aircraft and two catapults are carried, the hangar being between the funnel and after superstructure. According to unofficial returns the armour is as follows:—A 12in. to 13in. belt amidships, with 3in. to 4in. at ends, there being 12in. armour on the gun turrets and 6in. on the decks. The machinery comprises a three-shaft arrangement of geared turbines with oil engines for cruising purposes, steam being generated in high-pressure water-tube boilers. The designed

speed of the ship is 27 knots and was considerably exceeded on trials. She was laid down in 1934 at Wilhelmshaven naval yard and was completed on January 7th, 1939.

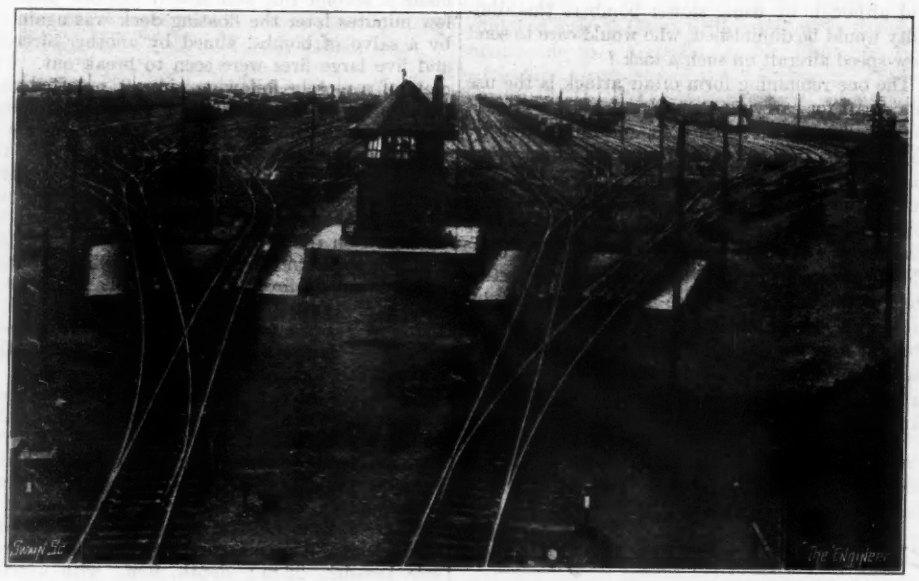
GERMAN RAILWAY FACILITIES AT HAMM

The successes achieved by Germany as a belligerent power have been due in large part to her realisation that success in any modern war will be largely dependent on an efficient transport organisation. The theory, carefully cultivated in certain quarters, both here and in Germany, that the German railways suffered seriously from undermaintenance and lack of renewals during recent years, was never accepted in those quarters which were in close touch with the progressive methods and characteristically thorough organisation steadily pursued since 1926 by Dr. Julius Dorpmüller, first as Generaldirektor and more recently as Minister of Transport.

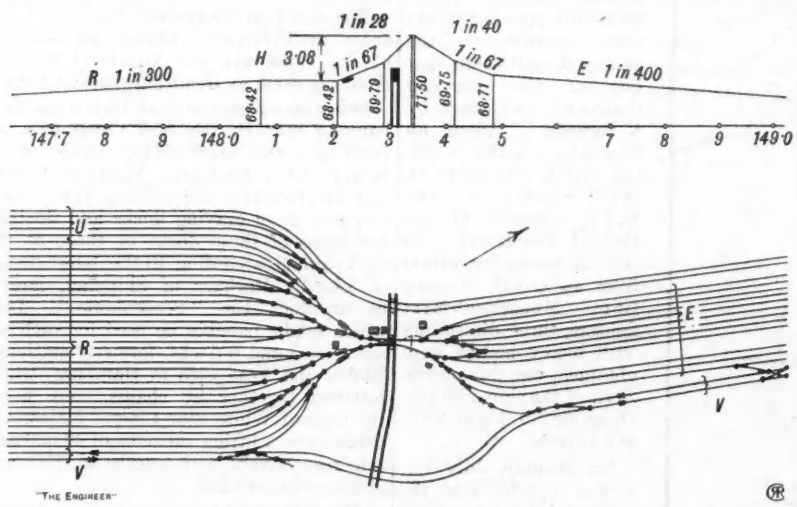
In no field of railway practice has the German railway attained greater pioneering success than in marshalling yard technique, and in that sphere the work of Dr. Frölich stands out pre-eminently. Whilst several German yards have been equipped since 1920 with his type of rail brakes, it was their outstanding success at Hamm that led to their subsequent adoption on railways in other countries, such as Great Britain, France, and Sweden. Hamm is situated at the eastern entry to the Ruhr and is reputed to be the largest marshalling yard in Germany. By the adoption of the rail-brake system the traffic passing to and from the Ruhr and the rest of Germany was not only speeded up, but so greatly was the capacity of the "hump" serving the westbound traffic increased that it was found possible to concentrate marshalling work on Hamm, which had previously been carried out at other less efficient yards, and, by this very concentration, the unit cost of dealing with wagons at Hamm was considerably reduced.

The German authorities, realising to the full the immense value of rail transport to the life of a country and to the defence forces protecting that country, in all their offensives, made attacks on key railway junctions and marshalling yards their prime aim. Examples could be quoted from the Polish campaign, the Dutch and Belgian invasion, and the more recent successful invasion of France. Thus Abbeville, Longueau (near Amiens), Sotteville (near Rouen), and Rennes all suffered from these unwelcome activities. A policy which proved so fruitful of success to Germany was not likely to be left long unused by her opponents, and it is in this connection that Hamm yard, long famous to railway operating officials throughout the world, has sprung into pre-eminence as an aerial target. Hamm has no counterpart in this country nor in France, since industry is not so localised in these two countries. Though dealing largely with mineral traffic flowing from the Ruhr mines to all the rest of Germany except the Rhine, it is by no means a mineral yard only, for through it passes much of the heavy traffic from the Ruhr and Wuppertal steel and engineering works to the northern ports, Scandinavia, the Baltic States, Hanover, Brunswick, Berlin, Halle, Saxony, and, indeed, most of Germany. Westward traffic passing through the yard consists of pit props, iron ore, and all the raw materials for the industrial Ruhr.

The Frölich type of rail brake has been previously described, but it may be mentioned that so efficient is this brake that a typical train of, say, sixty wagons, with perhaps over forty destinations, can be handled over the "hump" and distributed into the various sorting sidings in under seven minutes. It is therefore not a matter for surprise that this large railway centre, which is reputed to be able to deal with nearly 8000 wagons per day, has featured frequently in the day-to-day war news, as the part it plays in Germany's war effort is doubtless striking.



HAMM MARSHALLING YARD CONTROL TOWER AND RETARDERS



HAMM MARSHALLING YARD

Obituary

ALFRED ELLIS ASH

MANY of our readers connected with marine engineering will regret to learn of the death last week of Mr. Alfred Ellis Ash, which took place in a nursing home in Birkenhead, following some weeks of illness. Mr. Ash was the superintendent engineer of the Lancashire Shipping Co., Ltd., the managers of which are James Chambers and Co.

Mr. Ash was born in Wakefield in 1868, and was educated at Royston School, near Doncaster, Queen Elizabeth Grammar School in Wakefield, and Bradford Engineering College. He began his engineering apprenticeship at the Cunard Line's engine works, Bootle, Liverpool, in 1885, and four years later he went to sea as an engineer in one of the Cunard Mediterranean ships, the "Malta." From her he was transferred to the "Aleppo," the first ship in the Cunard fleet to be propelled by a triple-expansion engine.

Subsequently, he served in the famous record-breaking liners, the "Campania" and "Lucania," and while in the former he put forward the suggestion that the fitting of retarders to the boilers would improve the steaming and reduce the coal consumption of the ship. The result was a reduction of 50 tons a day in coal consumption.

In 1897 Mr. Ash left the sea to become works manager of the Vauxhall Engineering Company, then builders of marine engines and auxiliary machinery at Vauxhall, London, S.W. Within eighteen months he was appointed a director, and in 1902 he and another director designed and built the first Vauxhall motor-car. He returned exclusively to marine work in 1912, when he was invited by the late Sir John Esplen, Bart., to join the firm of William Esplen and Sons, the consulting marine engineers and naval architects, of James Street, Liverpool.

During the war of 1914 to 1918 Mr. Ash served for a time on the staff of the Ministry of Shipping. After the war he was concerned with the design and construction of the motor cargo vessel, "Raby Castle," which was equipped with North Eastern-Werkspoor machinery. In 1929 he designed the coal-burning installation in the "Berwindlea," the first British ship to be equipped with pulverised coal firing. In 1930 Mr. Ash resigned his directorship of Messrs. Esplen in order to take up the post of superintendent engineer of the Lancashire Shipping Company, Ltd. His latest ships were those fitted with North Eastern Marine reheater engines.

Literature

Principles of Industrial Organisation. By DEXTER S. KIMBALL, A.B., M.E., LL.D., and DEXTER S. KIMBALL, jun., M.E. McGraw-Hill Publishing Company, Ltd., London. 1939. Price 26s. net.

IT is not surprising that many books have been written on industrial organisation, because it is becoming increasingly true that "industry is the business of the civilised world, and the greater part of our problems—national, State, and home—centre around the great industrial problems." As enterprises grow in magnitude, so the problem of organisation increases, and the investigation of this complex subject from the American standpoint is very clearly conducted by the authors, who evidently appreciate that there is no finality, but rather that the industrial structure must be modelled and adapted to keep pace with national, legislative, and other changes that take place.

It is rightly suggested that to form a correct conception of the present position it is desirable to have some knowledge of the background, and past history, of industry, to which the first four chapters are devoted, indicating the effect of the "industrial revolution," the rapid development of inventions, and the growth of enterprises from small dimensions to their present large proportions. The book before us may be divided broadly into three main sections, the first that to which allusion has just been made; the second that devoted to a consideration of the main functions of organisation, including policies, location of plant, co-ordination and executive control, control of production—leading up to time and motion studies—purchasing, standardisation, depreciation, inspection, costing, and estimating, to mention the more important branches; and the third that which is concerned

with the human side of industry, and one which we are glad to see the authors approach in an understanding manner, paying considerable attention to it, and dispelling the myth that labour is a commodity that can be bought and sold in the same way as material, provided premium or other systems are installed that can appeal to the cupidity of the worker. They rather elevate labour to a higher plane, and seek to inspire the whole organisation with a spirit of true mutuality and trust, at the same time indicating some of the things which can be done to bring about the right outlook in industry. In a most interesting concluding chapter, entitled "Résumé—Science in Industry," not only is emphasis laid on the fact that the science of production is far ahead of that of distribution, so that goods are produced in lavish quantities, and yet a state of pauperism and wretchedness still exists in certain quarters, but the authors sagely affirm that in future it will not be enough for labour-saving management to increase profits, but "it must justify its place in our social economy."

In a work of this scope, attention is naturally devoted to general principles rather than to detail, and no particular card systems or other panacea are advocated; nevertheless, there are a few points that perhaps warrant criticism, among which might be mentioned the statement that "the chief inspector is put directly under the superintendent or principal officer in charge of production," for we are convinced that for the best results inspection must be entirely divorced from the manufacturing side. This is a view that is being taken in this country to an ever-increasing extent. We are surprised at the scant attention paid to the important subject of estimating, feeling as we do that a properly organised estimating department may prove to be the very backbone of the concern. It is all very well to brush it aside by saying that "in the absence of recorded costs of products closely similar to that upon which the estimate is made, personal judgment usually becomes a factor in the problem," but we suggest that it must be reinforced by accurate estimating. It should be possible to estimate for an entirely new product with confidence, given efficient rate-fixing and cost-accounting departments, and properly trained estimators, but unfortunately even nowadays estimating is often left to clerks.

It is perhaps on that side of industry affecting the human being that we find ourselves most fully in accord with the authors, for they evidently appreciate its significance; engineers in Britain would do well carefully to consider this subject in the light of the useful suggestions made. It is clearly shown how the introduction of specialised machine tools may result in the degradation of the worker, but the converse is often overlooked, in that at the same time the labour in another sphere, *e.g.*, the tool room, may be elevated. Standardisation certainly may tend to destroy individuality if carried too far, and given undue prominence it might adversely affect our artistic life, but undoubtedly within defined limits it is of incalculable value. When dealing with the important subject of time and motion study, which is explained lucidly, the necessity for interesting the worker is rightly stressed, and it is pointed out how easy it is for schemes to fail as the result of the antagonism of the worker. We are informed that "the secret of successfully managing a large enterprise is to organise, deputise, and supervise," but what a vast human sphere is covered by these three functions! In days when dictators are seeking to impose their wills on the world, it is interesting to read of those who favour "industrial democracy," who would seek to apply psychological and mechanical tests in an endeavour to fit the worker for the job, and who would train foremen in foremanship, and utilise college-trained men in the most appropriate way. Along these lines lies real progress. Once we realise that "men live one-fourth of their lives under the factory roof," we shall be more ready to pay attention to the general conditions under which they work.

A table setting out the causes of failure of industrial enterprises in ten different years is of special interest in that it shows that about 60 per cent. are due to lack of capital or to incompetence, whereas under 3 per cent. can be attributed to competition.

We are glad to observe that attention is directed to the loss attributable to material wasted in the factory, while later on in the book allusion is made to the possibility of bonuses for waste elimination. This, however, recalls to our mind the case of a company that appointed a waste inspector, and it was subsequently brought to light that a confederate was actually organising waste, for the purpose of the inspector detecting and eliminating it!

British engineers will certainly profit by reading this book, and benefit by the experience of American engineers.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

MOBILISING THE HOME WORKSHOPS

SIR,—There is still an unemployed reserve of useful equipment and mechanical skill in this country. I refer to the home workshops and services of model engineers and amateur mechanics, of which there are a large number capable of producing excellent work. Many of these workshops are well equipped with tools, and though the owners may be engaged during the day on some form of national service or may be over military age, they are willing and anxious to devote their spare time to the production of munition details. During the last war hundreds of thousands of shell bases and fuse and gauge parts were machined in home workshops of this kind.

I am now compiling a register of these workshops, and already have over 300 offers of service. The spare-time production of one worker may not be much, but in the aggregate the production may be a valuable contribution to the country's munition needs. If each worker devotes twenty hours a week to the work, the total result of 6000 production hours is equivalent to the work of 100 full-time mechanics in the factory. I know of one small group of retired people in the Home Counties who by well-planned effort are producing 1000 machined pieces a day for a nearby works.

My register is growing daily and my desire is to find suitable work for these enthusiastic volunteers to do. They are situated in all parts of the country. Some of them are capable of doing precision work to micrometer limits, others could do useful roughing out at lathe or bench. They may not be able to deal with the heavier products or components required, but there are hundreds of jobs to be done within their capacity, particularly in connection with tool and gauge and jig making, or with the lighter kinds of munitions. Some of these workers are already co-operating with the excellent technical school scheme organised by the Board of Education, but there are many others who are still looking for something useful to do. If any of your readers are in a position to make use of such additional production service, I shall be happy to furnish them with the names and addresses of likely helpers in their area. Every lathe which is kept turning is contributing to ultimate victory.

PERCIVAL MARSHALL.

The Model Engineer,
60, Kingsway, W.C.2,
July 5th.

IRON AND STEEL SCRAP

SIR,—Those industries which use iron and steel, or whose equipment involves the use of machinery, have been approached by the Iron and Steel Control with a view to their making available such supplies of iron and steel scrap as are in their possession. There has been a considerable response to this appeal, and that response has been largely helped by the ready co-operation of the technical Press. There is, however, evidence that there is still a large amount of available iron and steel lying in factory yards and sheds, and in maintenance departments, which might well be surrendered as scrap in the national interest at the present juncture.

Everybody is aware that it is characteristic of maintenance engineers and those who are in charge of repair and maintenance departments of works generally, and who are keen and conscientious, to make it a habit to keep supplies of spares, and, indeed, of obsolete parts of machinery, lest on some future occasion when the need arises they should be found short. There can be no criticism of this attitude. On the other hand, the national need for all the available iron and steel, either as discarded machinery and parts, or as scrap, is so great to-day that it outweighs even the advantages of providing against the future so far as individual firms are concerned.

I am therefore writing to you in order that, through the medium of your paper, I may appeal to heads of firms to see that as much of this kind of material as possible is given up for the purpose of being converted into iron and steel for munitions and armaments. May I suggest to them that even the provision of what may possibly be needed in the future by their own firms should take second place to the urgent national need? We all know that armaments and munitions for the fighting forces are needed in ever-increasing quantities. These cannot be provided in abundance unless a continuous flow of scrap is forthcoming. Therefore, I make this further appeal that everyone should join in this drive, even if it involves a little personal sacrifice.

H. E. CRAWFURD.

Scrap Iron and Steel Campaign,
427, Bush House, W.C.2,
July 4th.

Sixty Years Ago

WHY DID THE TAY BRIDGE FALL?

IT is still sometimes said that no one knows exactly what caused the Tay Bridge to fall on the evening of December 28th, 1879. Nevertheless the reports of the Board of Trade commission of inquiry into the subject published in our issue of July 9th, 1880, did not lack precision in assigning both general and particular causes for the disaster. The commission consisted of Mr. H. C. Rothery, a lawyer, and two engineer assessors, Col. W. Yolland and Mr. W. H. Barlow. Mr. Rothery presented one report and the assessors another. The verdict was the same in each, although expressed in different words. Mr. Rothery, acting the part of a fearless and outspoken judge, did not hesitate to say that Sir Thomas Bouch was from first to last responsible for a disaster which had reflected discredit on the engineering profession. The bridge, he said, was badly designed, badly constructed and badly maintained, and its downfall was caused by inherent defects, which must sooner or later have brought it down. Col. Yolland and Mr. Barlow, probably with a desire to screen a professional brother, did not attach blame to any specific individual, but contented themselves with a precise statement on the technical causes of the accident. Both reports were in full agreement as to the immediate origin of the disaster. It may be recalled that the piers supporting the spans which collapsed consisted of six cast iron columns mounted on a brick-work and stone foundation and tied together in a hexagonal group by means of wrought iron tie bars running horizontally and diagonally from lugs cast on the sides of the columns. There was abundant evidence to show that the cast iron employed was sluggish when melted and presented difficulties in obtaining sound castings. In a number of cases the lugs were missing when the columns were withdrawn from the moulds and to remedy the defect the lugs were subsequently "burned-on." In addition, it would appear that the holes in the lugs for the reception of the tie bar bolts were left "as cast"—that is to say, with a tapered bore—with the result that the bolts were provided with a very imperfect seating. The commissioners accepted without hesitation the fracture of the lugs and the consequent deprivation of the cast iron columns of their cross bracing as the prime cause of the disaster. . . . To-day it is usually said that the Tay Bridge fell because it was badly designed. In addition to the evidence forthcoming as to the failure of the cross bracing of the piers, the inquiry revealed an amazing degree of divided authority and incompetence in the design of the bridge. It appeared from the evidence that all the calculations made in connection with the bridge were entrusted by Sir Thomas Bouch to Mr. Stewart, a mathematician and engineer. Sir Thomas, during the course of the inquiry, was asked whether he had made any allowance for the pressure of the wind on the bridge. He replied that he had "made no special allowance whatever." When pressed on the point he said that he believed Mr. Stewart in his calculations had allowed for a pressure of 20 lb. per square foot. How far Mr. Stewart was competent to design a bridge was illustrated by a statement which he made concerning the effect on the structure of the Tay Bridge of any loosening of the tie bars in the piers—an occurrence borne out by certain evidence. Mr. Stewart replied that such loosening "would add to the strength and stability of the structure." In view of that reply it was suggested to him that if the bridge were stronger with the ties slack than when they were tight it was a waste of energy to tighten them. His reply was that it was "very hard to answer those philosophical questions." Mr. Rothery's scathing comment on this portion of Mr. Stewart's testimony was that if it were true, the stability of a ship's mast would be increased by the loosening of the shrouds.

DURBAN-SYDNEY AIR SERVICE.—A weekly air service with limited accommodation for mails has been established between Durban and Sydney, and the Postmaster-General announces that air mail correspondence for Australia, Burma, Ceylon, Egypt, Hong Kong, India, Iraq, Kenya, Malaya, New Zealand, Palestine, Sudan, Tanganyika, and Uganda, prepaid at the rate of 1s. 3d. a half ounce (postcards, 7d.), will be forwarded by surface route to South Africa and thence by air within the limits of the available aircraft accommodation. As the correspondence will be forwarded by steamer to South Africa, the acceleration over transmission by ordinary mail is not likely to be as great as formerly.

Contraction in Grey Cast Iron*

By E. LONGDEN, A.M.I. Mech. E.†

(Continued from page 12, July 5th)

Test on Long Bed Castings

Figs. 4 and 5 illustrate the cooling behaviour of a 41ft. 6in. long bed casting for a roll grinding machine. The design and dimensions of the bed are outlined by the inset in Fig. 5. A cross-sectional elevation of the bed across the points Z Z of the portion of the longitudinal elevation L is shown at E.

The casting is poured in the reverse position to that which is shown in the sketches, Fig. 5, with the slideways on the bottom face of the mould. The cooling behaviour is followed and checked, as previously described. In this case, however, four curves were formed. All allowances have been made in the curves for the expansion of the rods due to heating, and also for the curvature of the casting consequent upon the camber necessary to produce a straight casting. Camber is required downwards (in the centre as poured) and sideways (in the centre) in the direction indicated by the arrow K in Fig. 5.

The early volume changes of the casting are expressed in minutes in the graph, Fig. 4, and the complete movements, in hours, are shown in Fig. 5. The letters A, B, C, and D identify in the graphs Figs. 4 and 5 the curves taken of the cooling casting, on the lines indicated by A, B, C, and D in the sketch E, Fig. 5. The line of contraction A carries the heaviest mass of the casting—the vee slideway. The line B holds the flat slideway, being the second heaviest line of contraction. The line C influenced by the extra metal at H thereby takes the third position in order of mass influence, and D the lightest and most quickly cooled and contracting line.

Referring to the minutes' curve in Fig. 4, the following movements are indicated :—

Curve D.—At 7 minutes an arrest and expansion of 25 thousandths occurs and lasts for 28 minutes. At 68 minutes a second arrest is shown covering a period of about 30 minutes. A third and fourth slight arrest may be detected at 140 and 220 minutes respectively. The curve then indicates a steady contraction with only small fluctuations.

Curve B.—At 9 minutes an arrest and expansion of 46 thousandths is noted, lasting for about 30 minutes. At 130 minutes a second arrest, for 65 minutes, occurs. At 207 minutes a third arrest appears, lasting for about 30 minutes. The remainder of the curve records only small fluctuations.

Curve C.—At 8 minutes the record shows an arrest and expansion of 55 thousandths, lasting for about 25 minutes. At 180 minutes a small arrest occurs for 15 minutes. At 240 minutes a third small arrest can be identified. The curve following is steady until final cooling.

Curve A.—At 10 minutes an arrest and expansion of 75 thousandths is shown over a period of 40 minutes. A second arrest is indicated at 150 minutes, lasting for 20 minutes. At 195 minutes a third, sharp arrest is recorded, lasting for 15 minutes. A fourth arrest occurs at 265 minutes, which covers a period of 65 minutes. A fifth slight arrest is indicated at 395 minutes. After 430 minutes the curve shows a steady contraction rate.

The standard contraction allowance for a 41ft. 6in. casting is 5188 thousandths. The actual final contraction of the bed is as follows :—A, 4978 thousandths, which is 96·0 per cent. of the standard allowance ; B, 4904 thousandths, which is 94·6 per cent. of the standard allowance ; C, 4251 thousandths, which is 82·0 per cent. of the standard allowance ; D, 4182 thousandths, which is 81·0 per cent. of the standard allowance ; average contraction, 87·4 per cent. of the standard allowance. Between the lowest contraction of D and the highest contraction of A there is a difference of 796 thousandths. A C side has contracted an average of 72 thousandths more than B D side. A (bottom heavy vee slideways) has contracted 74 thousands more than B (bottom flat slideway). A, bottom, has contracted 727 thousandths more than C, top. B, bottom, has contracted 722 thousandths more than D, top. The average contraction of A B (bottom face) over C D (top face) is 725 thousandths.

Camber Allowances.—These varied contractions, recorded on the four extremes of the castings, confirm the camber allowances needed to counteract distortion due to the differing heat gradients and the hindrance, by design, to free contraction. The camber allowance downwards was 2⅜in., which must be associated with the excess contraction of 725 thousandths of A B (bottom face) over C D (top face). The camber requirements on the A C (heavy) side was ⅜in. This allowance must be associated with an excess contraction of 72 thousandths of the A C side over the contraction of the opposite side B D.

Without the heavy facing S on the A C side, it is necessary to allow approximately ¼in. more camber on the A (heavy vee slideway) line than on the B (flat slideway) line. The influence of the heavy side facing S was to reduce slightly the downward camber, but to create, along with the heavy vee bottom slideway, a side distortion if not counteracted by camber allowance.

It will be noted on close examination of the cooling curves that B (bottom flat slideway) contracted slightly ahead of C (top with side facing), and then later falls behind to take its place in order of mass cooling. This may be due to the early effect of the denseners on the B slideway and the acceleration of the cooling rate immediately after solidification of the metal. The C (top side), however, is influenced by a heavy facing, carrying nearly as much metal as B (bottom) which is also densened. Since the side facing is subjected to a sharper cooling, by virtue of its outward position in the mould, cooling and contraction are subsequently more rapid than B, which is located in the bottom of the mould. Again, much of the heat absorbed by the denseners is retained by the densener to slow up the rate of cooling at a later period.

Adverting to the arrests in the cooling curves, it is possible that the influences, when cooling has reached a stage when a considerable difference in contraction stress is upon the casting, cause a late arrest which is not actually due to an expansion, but may be attributed to distortion of the casting.

Test Castings

Fig. 6 illustrates by sketches the design of a test casting, 10ft. by 2ft. by 7in., and graphically the cooling curve and final contraction of the casting. The sketches show that the casting consists of a series of bars of varying sections making one unit. The outside longitudinal bars carry a 4in. flange, 1in. thick, forming, with a vertical ½in. bar, a tee section. The inner bar is heavier, having a 5in. by 2in. flange mounted above a ½in. vertical bar, again forming a tee section. The cross bars are plain bars of ½in. section.

The test is arranged to create an exaggeration of the cooling conditions present in certain types of castings, particularly of bed designs. The composition of the metal poured into the casting was such as to yield a grain structure as might obtain in a much larger casting with a lower silicon content. The analysis is set out in Fig. 6.

The volume changes were checked on three contraction lines, indicated by the letters X. The behaviour of the two outside longitudinal bars was so similar that it became unnecessary to draw a curve for each bar. They were therefore merged and are plotted together in the curve C in the graph, Fig. 6.

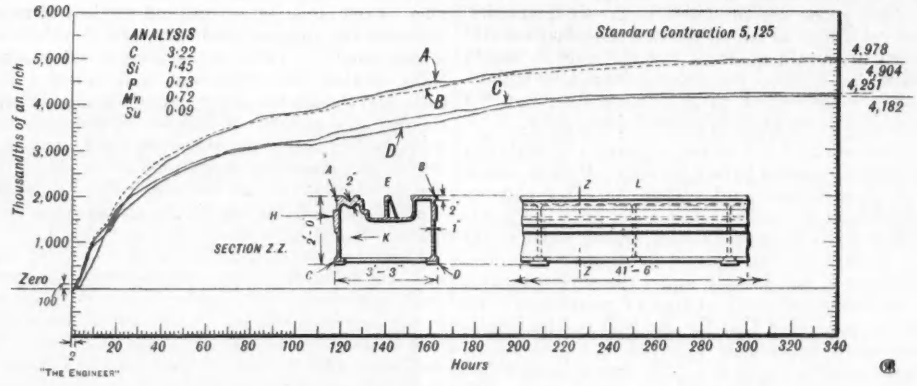


FIG. 5—*Cooling Behaviour of a Roll Grinding Machine Bed*

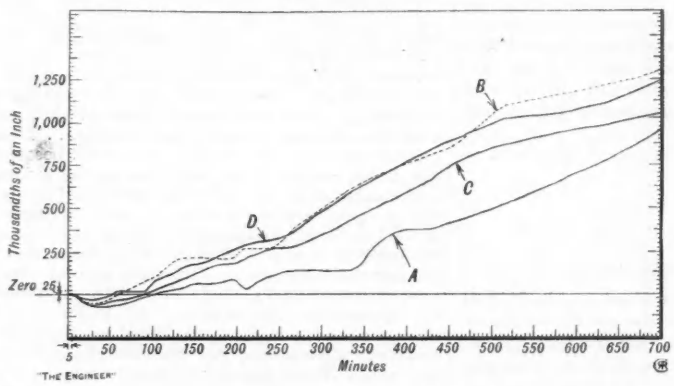


FIG. 4—*Cooling Behaviour of a Roll Grinding Machine Bed*

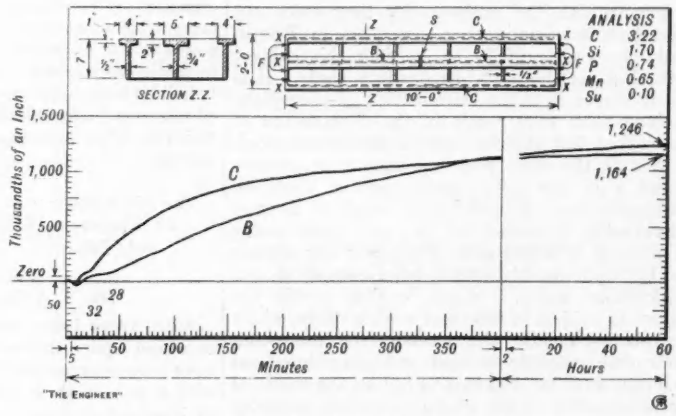


FIG. 6—*Design and Thermal History of Test Casting*

The curve traced for the movement of the centre bar is identified by the letter B.

The curve C shows that an arrest occurs at 4 minutes with an expansion of 28 thousandths. A second mild arrest and slowing up of the rate of contraction occurs at 20 minutes. With B curve an arrest is recorded at 5 minutes with a 32 thousandths expansion. A third arrest and slowing up of contraction occurs at 28 minutes. A steady contraction follows. The heavy centre B passes and exceeds the contraction of the outer lighter bars C at 375 minutes.

The final contraction of the casting came out at 1246 thousandths for the heavy centre bar B, being only 4 thousandths below standard allowance, and 1164 thousandths for the outer lighter bars C, which represents only 92·5 per cent. of standard allowance. The casting was bent (down in the centre as poured) by ⅝in. along the line B and 1/16in. on the lines C. The casting was also fractured at six points, indicated by F in Fig. 6.

The usual allowances were made in the final figures for the expansion of the rods due to heat and the curvature of the distorted casting.

A further test was taken, but with the middle bar B split by a core, as described at S, Fig. 6. The behaviour during cooling is interesting. The lines C contracted 1252 thousandths (close to standard allowance), against 1164 thousandths for the same dimension of bar in the first test casting. This means that the bars in the first casting contracted 88 thousandths less than the bars in the second casting.

The two middle bar sections B, together, contracted 1238 thousandths, which is 12 thousandths less than standard. The gap S, severing the bar in the centre, had, after cooling, widened by 187 thousandths.

The distortion in the second test, with the heavy centre bar split into two sections, was less pronounced than in the first test, where the casting is not split across the centre bar. The lines C and B cambered 1/16in. Furthermore, no fractures appeared at the points F.

Conclusions

All of these tests offer substantial support to the previous experiments carried out by the author and presented to the Institute over a number of years.

* The Institute of British Foundrymen.

† Manager, Foundry and Pattern Shops, Craven Brothers, Ltd., Machine Tool Engineers.

The conclusions are that on the classes of iron castings surveyed, thick bars or sections contract more than thinner bars or sections, where such varied sectioned members are linked together, as a single-piece casting, in a proximity to be affected by mutual influences. If, however, the same contrasting sections are cast as simple uniform and separate items, contraction is in line with standard allowance and knowledge—that a thin section of grey iron contracts more than a thicker section for the same analysis, because of the more rapid freezing of the lighter section and the effect of this more rapid cooling on the grain size and graphite formation.

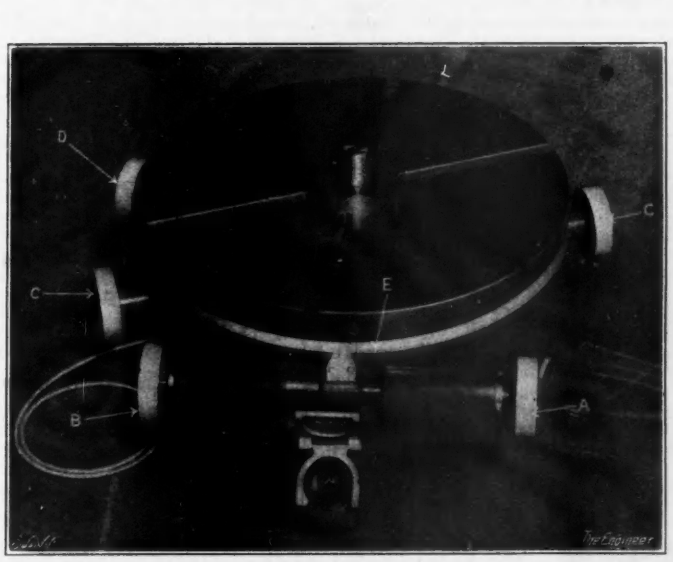
A probable explanation of the two contrary degrees of contraction referred to is that in the case of a one-piece casting the thin or comparatively light sections are subjected to an extensional stress, during freezing and cooling of the metal, created by the resistance of the thicker sections which are not ready to contract. The frictional resistance of the mould and cores, and the expansion of cores on being heated up by the molten metal, will also tend to subject the cooling metal to extensional stress. Again, a study of the very clear arrest and expansion periods noted on the cooling curves, especially those of the heavy and large boring bars, indicates that a thick section of a casting may be undergoing an expansion at a time when a thinner section has passed its expansion phase, and is in a state of contracting. Under these conditions, the thin sections will suffer extensional stress.

Conversely, the thicker sections will be subjected to a compressional stress by the effort of the earlier cooled members to contract. Finally, the heavy sections on cooling must take up a shorter length by bending certain sections of the casting or by fracture in the weakened or most highly stressed sections.

The author's thanks are tendered to Mr. J. R. Greenwood (chairman) and the directors of Craven Brothers, Ltd., machine tool engineers, for facilities to obtain information for this paper.

Optical Circular Table

MANY months before the outbreak of hostilities, the Newall Engineering Company, Ltd., of Peterborough, decided to manufacture an optical circular table similar to that manufactured by the Karl Zeiss Company, of Jena. On the outbreak of hostilities manufacture was dictated by necessity, and the preliminary development work undertaken before the war proved of great value. The aim and object was to provide a table fully the equivalent of the German product as regarded ease of operation and accuracy. The company makes grateful acknowledgment to E. R. Watts and Son, Ltd., of London, who, as suppliers of the microscopes and precise scale, have effectively co-operated in the production of the table.



OPTICAL CIRCULAR TABLE

The Zeiss table has for a long time been considered outstanding in its field, and after producing the first table of that pattern, the Newall Engineering Company, Ltd., submitted it to the National Physical Laboratory for tests. The outstanding feature claimed for the table, which has been manufactured to deal with all kinds of work on jig boring, milling, drilling, and other machines, is that it ensures accurate division without the possibility of deterioration in accuracy caused by wear of the indexing mechanism. Indexing is obtained by means of a glass scale mounted on the rotating portion of the table. The scale is viewed through an eye-piece situated at the front, and in the image seen by the observer each graduation, at approximately $\frac{1}{16}$in. distance apart, represents 30 sec. of arc. A reading accuracy of one-fifth of that amount should, it is stated, be quite possible to the average observer.

The knob A provides fine adjustment for the table. Knob B enables this fine adjustment to be locked. Knobs C lock the table top and when unclamped permit the free rotation of the table top. Knob D releases the rough setting ring E. The table can be centralised under the boring spindle of a jig borer by employing a dial indicator attached to the boring spindle and rotating the indicator round a centre which is fixed in a taper hole lying in the vertical axis of the circular table.

While being very accurate, the table is sufficiently rugged to enable it to be used continuously for large and heavy types of work. It is particularly suitable for use in conjunction with jig boring machines when a number of holes have to be bored at exact radial centre distances and angles. All optical parts are entirely enclosed, so that cutting lubricant or chips cannot penetrate to cause damage. The table is also claimed to be a very valuable adjunct in an inspection department for use purely as a checking device. The outside diameter of the table is 16in., the height is 7$\frac{1}{2}$in., and the weight is about 235 lb.

The complete manufacture of this table is being carried out by Optical Measuring Tools, Ltd., Montrose Avenue, Trading Estate, Slough, Bucks, which firm is a subsidiary of the Newall Engineering Company, Ltd. The sole selling agents, E. H. Jones (Machine Tools), Ltd., Edgware Road, The Hyde, London, N.W.9, inform us that present indications are that the table will be available for delivery in quantities in September this year.

The following test results are taken from the N.P.L. report on the table submitted to it for examination:—

Table: (i) *Upper Surface.*—The upper surface of the table, which has a scraped finish, was found to be slightly concave by 0·0003in. With the table unclamped, its surface was found to be in the mean out of parallel with the base of the table by 0·0005in. to 0·0006in. The rim of the table was found to run true to within 0·0002in.

(ii) *Central Hole.*—The parallel portion of the plug which fits the central hole in the table was found to be cylindrical to well within 0·0001in. The parallel and tapered portions of this plug were concentric to within 0·0001in. When this plug was fitted in the taper socket of the table and the latter was rotated, an indicator set to read on the parallel portion of the plug did not show a variation of more than 0·0001in. Readings taken towards the extreme ends of the parallel portion of the plug indicated that its axis was perpendicular to the table to within 0·0001in. over its 1$\frac{1}{2}$in. length.

(iii) *Effect of Locking the Table.*—When the two diametrically opposed locking screws were brought into use, applying light hand pressure, the level of the table in the region of the locking screws was found to be depressed by approximately 0·0002in. [*Note.*—Care should be taken to exert a reasonably equal pressure on the two locking screws, otherwise there will be a tendency slightly to tilt the table.] The locking of the table did not affect the setting in the eyepiece.

Calibration of Circular Scale.—The angular scale of the table was checked at 30 deg. intervals and the errors found in the scale readings were found to be as given in Table I:

TABLE I.

Interval, degrees.	Errors in scale readings, seconds of arc.
0	0
0 to 30	0
0 to 60	0
0 to 90	+1
0 to 120	0
0 to 150	−1
0 to 180	+3
0 to 210	+3
0 to 240	+1
0 to 270	+2
0 to 300	−4
0 to 330	−2

The scale in the eyepiece was examined at six-minute intervals and the observed errors in the readings are given in Table II.

The accuracy of determination of the errors in the above Tables I and II is estimated to be of the order of ±3 sec. of arc.

Test Plate.—As a test on the accuracy of the table in practical use, a test plate was produced by the manufacturer on the table, using a jig boring machine. This test plate has been measured at the Laboratory with the assistance of plugs fitted to the bored holes. The axes of the holes were all found to be perpendicular to the upper surface of the test plate to within 0·00015in. per inch with one exception; this hole was in error by 0·0002in. per inch. The errors in the radial spacings of the holes 2 to 10

TABLE II.

Interval, minutes.	Errors in scale readings, seconds of arc.
0	0
0 to 6	−2
0 to 12	+2
0 to 18	+3
0 to 24	−3
0 to 30	+3
0 to 36	+3
0 to 42	+6
0 to 48	+4
0 to 54	+6
0 to 60	+3

inclusive with respect to the central hole 1 were found to be as given in Table III:

TABLE III.

Hole No.	Errors in radial spacings of holes with respect to central hole at 68 deg. Fah. (nominal spacing 6in.), inch.
2	+0·0003
3	+0·0002
4	+0·0003
5	+0·0002
6	0·0000
7	+0·0001
8	+0·0003
9	+0·0005
10	+0·0006

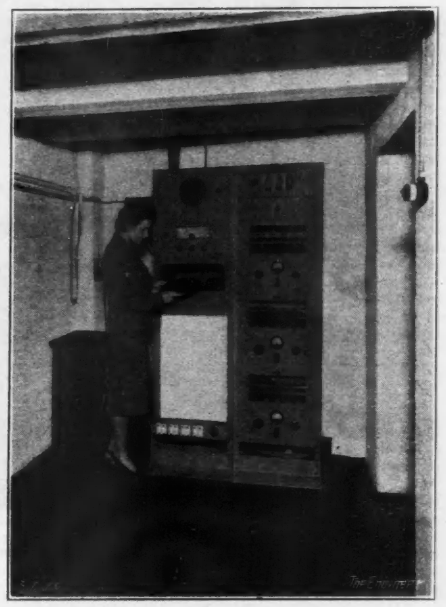
The errors in the angular spacing of the holes with respect to a datum line joining the centres of the holes Nos. 1 and 2 were found to be as given in Table IV:

TABLE IV.

Nominal angles.	Measured errors of angles, seconds of arc.
51° 25′	+ 2
77° 8′	+ 3
102° 51′	+ 1
154° 17′	+ 7
180° 0′	+ 7
205° 43′	+11
257° 8′	+ 9
308° 34′	+ 8

Broadcast Music in Workshops

ALTHOUGH opinions may differ concerning the value of music in workshops to reduce the monotony of workpeople engaged on repetitive processes, experiments are said to have shown that the scheme helps in certain cases to speed up production, and is particularly desirable in war time. Tests have apparently indicated that the increase in production, under favourable conditions, is not less than 6 per cent. The fact that the B.B.C. has begun broadcasting a series of special programmes, entitled "Music While You Work," is an indication that the scheme has received official recognition, although there is not much doubt that it is intended to apply more particularly to workshops in which light repetition work is carried out, mainly by girls.



RADIO, GRAMOPHONE, AMPLIFYING AND CONTROL EQUIPMENT

The apparatus required for the radiation of music is known as sound reproduction equipment. A complete installation usually includes provision for radiating gramophone music, broadcasting B.B.C. programmes, and general announcement facilities. The apparatus required for radiating gramophone music consists of a playing desk and an amplifier.

connected *viâ* a control panel to speakers placed in shops or workrooms.

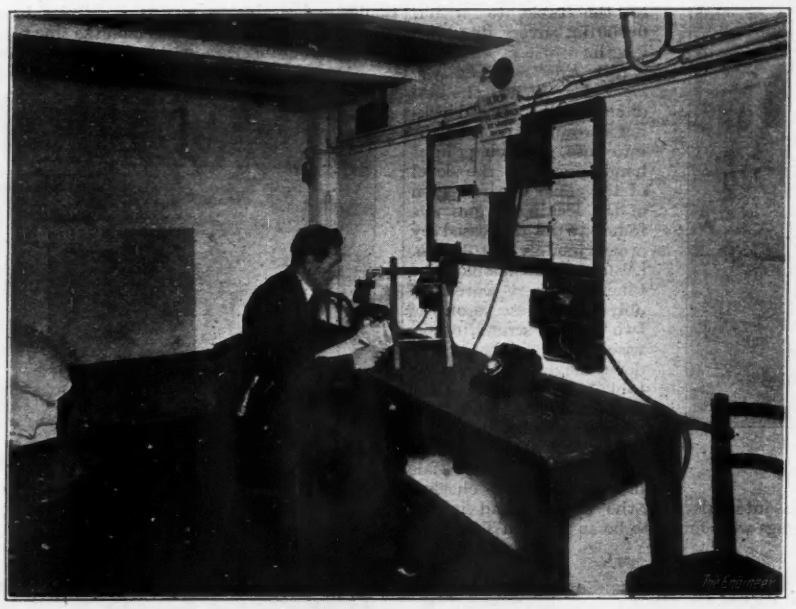
For diffusing wireless programmes, besides the amplifier and speakers such as are necessary for gramophone music, a radio receiver unit is also required. If the radio is used as a supplement to gramophone facilities, in addition to the special programmes which the B.B.C. are broadcasting, there are further advantages to be derived by use of the system. Programme items can, for instance, be varied to a greater extent, and the appeal of records of popular tunes given longer life. Another benefit is that vital news and special announcements can be broadcast without disorganising production.

The apparatus needed for general announcement purposes again comprises an amplifier and speakers, but these are connected to microphones at strategic points, *viâ* a control panel. It is usual for a microphone to be placed in an executive's office or central control room, and a second wired to the telephone switchboard. Other microphones can be added as deemed necessary. By this means an executive can call any member of his staff, *viâ* the speakers in the factory, should the latter be away from his usual working place. The executive can do this either directly from his office, or if he himself is away from his office, by telephoning the operator and asking her to broadcast a call. In large works a great deal of time can be saved in tracing men by this method. Instructions and announcements of a general nature can, of course, be issued in the same way.

Another purpose to which a system of this kind can be put is in connection with A.R.P. By extending the loud-speaker circuits to include air raid shelters and installing a microphone in the central A.R.P. control room, a scheme that may prove invaluable is provided.

Instructions can then be issued by the chief warden from the control room to workpeople in all parts of the factory or in the shelters themselves. Movement to and from the shelters from working places can be speeded up and order more easily maintained. The minimum amount of dislocation of production effort entailed during fire drills and false alarms is also thus ensured. Apart from verbal announcements by the warden, warning can also be given by radiating a pure tone note of recognisable quality, either by mechanical or electrical processes.

The processes in the majority of the production departments of the G.E.C. works at Hammersmith are concerned with the manufacture of radio valves and lamps of several categories. They are distinctly of a repetitive nature, and typical of the kind encountered in small-part mass production. Besides providing gramophone music, the installation comprises equipment that enables it to be used both for the diffusion of radio broadcasts and for A.R.P. and other announcement purposes. Two microphones, 220 speakers, amplifying apparatus, record-playing desk, radio and control panels are included. The employees' welfare department is responsible for the preparation of special programmes of B.B.C. and gramophone music. An extensive library of records is maintained and constantly renewed, there being about 250 discs in all, mostly of light music. A.R.P. and other announcement facilities provided are very much on the lines already generally described.



CONTROL ROOM AND MICROPHONE

The amplifying and associated equipment which comprises the system is situated in a control room, which is deep in the heart of an underground part of the factory. At one end of this room, shown in the first illustration, this apparatus can be seen mounted in convenient racks, the girl in the illustration being just about to put on fresh records for the gramophone music period. The amplifier has three 100-watt channels, taking the microphone, gramophone, and radio inputs through a remotely controlled relay panel. The remotely controlled relay panel allows appropriate switching from the telephone exchange or control room, shown in the second picture, according to which centre is being used for microphone announcements, it being possible to cut either of the microphones into the gramophone or radio programmes at will. There are 220 speakers fed from this equipment, situated in all parts of the factory, the type of speaker used depending on its situation.

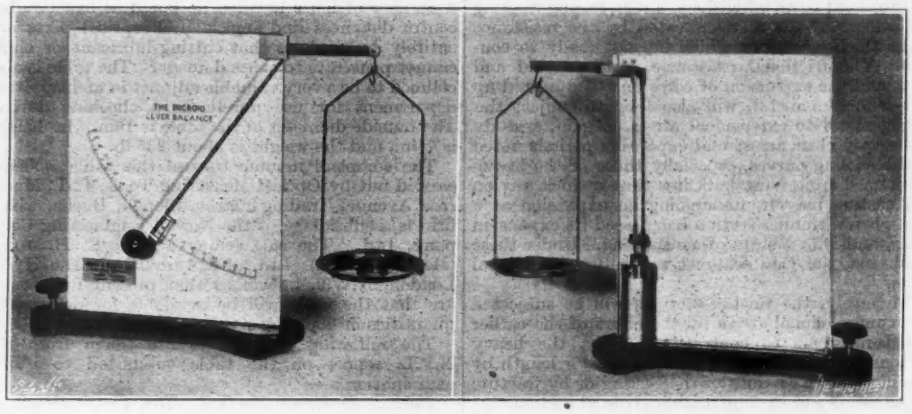
In the machine rooms, for instance, where the noise level is rather high, wide-angle projection speakers of the horn type have been provided. These successfully overcome all extraneous sound and counteract the absorption of broadcast music or speech by lathe belting. For general purposes where relatively quiet operations, such as hand assembly of valve parts, are conducted, the standard industrial pattern speaker is installed. In shops having approximately unity aspect ratio, square, concentric diffuser speakers are employed. These are designed to spread the sound in all directions at once, and are thus suitable for central mounting. Standard pattern domestic loud speakers are fitted in the executive and general offices. These speakers, together with those operating in the laboratories and in other situations where it is not advantageous to radiate music, are not connected with the radio or gramophone circuit.

It has been discovered that persistent noises of not too obtrusive a character affect enjoyment of programmes less than intermittent sounds, especially if the periods between the intrusions are irregular. By the careful placing and choice of speakers, however, this difficulty has been overcome.

Automatic Lever Balance

WE illustrate in the accompanying engraving two views of a new lever balance designed for rough or preliminary weighing in works, research, and school laboratories. Known as the "Microid" lever balance, it is made by Griffin and Tatlock, Ltd., of Kemble Street, Kingsway, London, W.C.2. It is an automatic, self-indicating balance—that is to say, it does not require the use of weights. Its maximum capacity is 200 grammes, and it can be read with an accuracy of 0·5 gramme.

The balance is mounted on a black, vitreous, acid-resisting enamelled base, provided with rubber feet and a levelling screw. A metal plate, about 12in. by 10in., is engraved with a scale reading 200 grammes in 1-gramme divisions. On the plate is carried the beam, which is mounted in a box type bearing with a single hardened steel pivot upon which the system swings. To one end of the beam is fitted a strip pointer designed to eliminate parallax and give easy reading. This end of the beam also carries a counterweight. The other end of the beam is provided with a hardened steel pivot supporting a double-hooked stirrup,



"MICROID" LEVER BALANCE, FRONT AND REAR VIEWS

from which the bows and a pan about 4in. diameter depend. From the short arm of the lever a link is connected to a rod fitted with a vane moving in oil in a dashpot mounted at the rear of the balance. The dashpot can be sealed to prevent oil leakage in transit.

It is claimed that the initial accuracy and sensitivity of the instrument are not impaired by use, because it has no knife edges to become blunted, and has only one main pivot bearing. Furthermore, its accuracy is independent of the position of the load on the pan, because the pan is "suspended." In certain types of balance in which the pan is placed vertically above the lever mechanism, the accuracy of the readings is affected by the position of the load.

Because of the oil-damped mechanism, the pointer swings smoothly and comes to rest without oscillation, and its action is rapid. We are informed that the weighing of five objects was found to take an average time of 6 sec. each.

South African Engineering Notes

(By our South African Correspondent)

CAPE TOWN, June 5th, 1940.

Copper Mines

The Tsumeb property of the Otovi Minen and Eisenbahn-Gesellschaft in South-West Africa started full-time production during the week ended May 11th. This is the largest copper mine in the territory and employs several hundred whites and over 1000 Ovambo natives. The ore produced is being exported in neutral ships to a large refinery at Tampico in Mexico. Before the war Tsumeb copper was sent directly to Germany. Presumably this mine is being worked under the control of the Union, seeing that South-West Africa is a German mandated territory.

Air Cooling Plant at Rand Mines

The constantly increasing depth at which mining operations are being conducted on the Witwatersrand gold mines, and the consequent increase in the rock and air temperature of working places, present one of the most serious technical problems the gold mining industry in South Africa has to face. At the present time several of the mines are making arrangements to install air cooling equipment. At the Crown Mines plant is to be installed on the surface at one of the shafts and it is expected that after it has been in operation for some time the experience gained will warrant the erection of further cooling stations at other deep shafts until all the deepest levels have been provided with cooled air. The operation of similar plants has shown that cooling effects underground would be sufficient to bring within workable limits considerable quantities of ore which would otherwise be lost.

The City Deep Mine is spending £250,000 during the current year, the greater part of which will be expended on an air cooling plant which it has been decided to install at No. 4 shaft, where the bottom levels have now reached what is virtually the working limit on account of heat. The new plant is expected to effect a considerable improvement in the western section of the mine and enable operations to be carried to a much greater depth than would otherwise

be possible. Another large undertaking, the East Rand Proprietary Mines, is also installing air cooling plant on the surface at the new central vertical shaft to improve ventilation. Workings at the central section are approaching their economic limits owing to high temperatures. The sinking of the Angelo tertiary incline shaft reached its final depth in February, permitting ore to be hoisted from the 59th level, 8000ft. below the surface.

Railway Workshops

During last year a beginning was made on the construction in the departmental workshops of the S.A.R. of all-steel bodies for the Administration's road motor vehicles. This experiment has proved successful and economical, and the all-steel body has now been adopted as standard, replacing the former wooden design. The special metal sections required for these bodies will be fabricated in the workshops. An experimental rail motor trolley made in the departmental workshops for the purpose of replacing an imported vehicle of this type has been successfully tested and fifty trollies are now under construction at the depot. Provision has also been made in the workshops and in those under construction at other centres for the building and repair of the various types of barrows used by the Administration, the result of which will be the standardisation and improvement of such equipment and lower initial and maintenance costs. The purchase of imported barrows has been discontinued. Considerable progress has also been made in the manufacture of spare parts for road motor vehicles, a phase of the work which will be developed as the workshops under construction and contemplated are brought into operation.

War-time Industries Warned

A warning against new industries which arise in war-time conditions, but have no inherent vitality, is contained in the report of the Board of Trade and Industries on the Customs tariff amendments incorporated in this year's Custom Bill. The report states that, judging from the experience of the World War, it is more than probable that extensions will in many instances be made to existing plant by concerns which are called upon to supply a greater part of the whole of the country's requirements in a particular direction, and that in addition new industries will come into being, some of which will have no inherent vitality. The Board therefore issues a warning note against the latter type of industry. The Board will always give due consideration to all applications for protection against undue foreign competition, but the mere fact that an industry, started under the conditions of war, should experience difficulty in holding its own does not of itself warrant tariff protection being recommended. The outbreak of war resulted in the Union being wholly cut off from its sources of supply, while others were restricted through considerable increases in freight rates, marine insurance and other shipping charges, which by themselves conferred added protection on some industries. Moreover, the Union's currency has depreciated by some 15 per cent. in terms of the U.S. dollar. The Union is therefore largely thrown back on itself industrially and local industries have come into a degree of protection not enjoyed previously. The Board has to consider the necessity of maintaining a flow of supplies from overseas and also consider the possibility of a sudden revival of overseas competition, possibly as a result of an unexpected cessation of hostilities. It does not therefore feel that there should be increases of duties and at most only suspended duties should be recommended. A certain degree of protection has, however, been recommended in favour of a number of industries by way of a reduction of duties or admission of materials under rebate of duty.

BOOKS OF REFERENCE

The Oil and Petroleum Year Book, 1940. London: Walter E. Skinner, 15, Dowgate Hill, E.C.4. Price 10s. net.—The new edition of this reference book gives full up-to-date details of 775 companies engaged in or directly associated with the oil industry in all parts of the world. In addition to lists of officials connected with the industry, useful lists of trade names and a glossary of trade terms are included in the book. The classified buyers' guide will prove particularly helpful to manufacturers in finding suppliers of plant and machinery used in the production of oil.

TEN YEARS' OPERATION OF A BLAST-FURNACE.—A note in the *Iron and Coal Trades Review* states that after ten years of continuous production, the 600-ton No. 2 blast-furnace at the Otis Steel Company's Riverside Works, Cleveland, has been shut down in preparation for rebuilding. The furnace, which was blown on May 20th, 1930, has never even been banked. It is believed that this is probably the longest period of uninterrupted use ever obtained on a single blast-furnace lining. The furnace was blown out on May 6th, after 1,735,500 gross tons had been tapped and poured into the adjacent open-hearth furnaces.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The United States Market

With the overrunning of France, Belgium, and Luxemburg by the Germans it became necessary for Great Britain to seek alternative sources of supplies of iron and steel, and the loss has been made up by the United States and Empire countries. These developments have naturally completely changed the situation in the American iron and steel industry. Only a few weeks ago the production of steel ranged from 56 per cent. in the Pittsburg district to 77 per cent. of capacity in Chicago. The average for the trade has now reached 87·7 per cent., and some works are operating at full capacity. In Detroit, Buffalo, and Chicago the rate is from 73 to 95 per cent., and from Pittsburg to Cleveland 82 to 83 per cent. Before France collapsed the French Government placed considerable orders for steel with America, but work on these contracts has now been held up, although most of them have been transferred to British account. This has caused a certain amount of delay as the dimensions had to be restated in metric inches in place of millimetres, and other similar changes made. The tonnage of the orders involved is understood to be about 500,000 tons, but this is not large considering that it represents only a half of one week's current output. The United States rearmament programme has also had a sharp effect upon the market, since orders for twenty-two naval vessels, involving the use of 75,000 tons of hull steel, have been placed. Domestic railway buying has increased and recent contracts have totalled 2760 steel freight cars, most of them of 50 tons capacity, and twelve locomotives. The pig iron market has also reacted to the more active conditions, and between 80 and 85 per cent. of the blast-furnace capacity of the country is now operating. Firm conditions rule in the scrap section, and inquiries have been received from Japan for about 150,000 tons. Orders for Italy are reported to have been taken over by Great Britain. No changes have been made in steel prices.

The Pig Iron Market

The advance in the prices of pig iron has had no effect upon the demand. So much of the production is required for work in connection with Government contracts that the price is of less interest to consumers than delivery dates. The advance on pig iron was not so sharp as in the case of steel and varies from 3s. 6d. to 9s. per ton. Basic pig iron has been raised by 6s. to 8s. 6d. to £5 13s. to £5 15s. 6d., according to district, but the requirements of the steel works are so heavy that every ton that is produced is immediately taken up. There have also been considerable imports of this description of pig iron, and with the home production plus imports the steel works are at least able to maintain operations at recent rates. At the same time, great care is necessary in the distribution. The prices of forge and foundry iron have been increased by 9s. except in the case of Scottish brands which have been raised by 4s. 9d. The position in the foundry iron branch of the trade has not materially changed over the past few weeks, and there is still some stringency in the supply of low-phosphorus iron. This is required in large quantities by engineerng firms engaged on Government work. The position of high-phosphoric iron is somewhat easier, but it is difficult to obtain an allocation of this quality excepting for work of national importance. The light castings industry, which normally was the largest user of this class of iron, has suffered a severe restriction in its ordinary domestic trade; but more units are being included in the national war effort and are getting Government contracts. There is, however, considerable slackness in this department. The situation in the hematite market is rather tight, and the producers are not finding it easy to meet the heavy requirements of the Midland and Sheffield consumers.

The North-East Coast and Yorkshire

All available plant on the North-East Coast is in full production and outputs have been largely increased. But if there has been an expansion in production the demand from consumers has broadened to an equal extent. The result is that the pressure upon the works remains as strong as at any time since the commencement of the war. All classes of steel are in request and lately there has been a big expansion in the call for special and alloy steels, a great deal of which are used in the manufacture of mechanised equipment. The major part of the demand is for joists, sections, and steel bars. There has been a large consumption of the latter, particularly of reinforcing bars, whilst the constructional engineer requirements of all classes of sections is on a huge scale. The works have struggled hard to maintain deliveries, but in spite of the most careful distribution arrangements there is a tendency for the makers to fall into arrears. All the shipyards on the North-East Coast have as much work as they can handle, and are taking up large tonnages of shipbuilding steel. The demand for plates has steadily increased during the past few weeks and there is a definite tightness in the market. The works producing semi-finished steel have been operating at capacity for months, and lately some fresh plant has been put into operation. Notwithstanding these efforts, however, production falls short of requirements. The re-rolling mills have been able to maintain a full rate of operations through the importation by the Control of good tonnages of semis from the United States and Empire markets, which have made good the loss of the Belgian and Luxemburg supplies. In the Yorkshire market the chief feature is the anxiety of consumers to obtain supplies. There is a big demand for basic steel, and the makers of soft basic billets are pressing their production to the utmost in order to satisfy the demands of their customers. There is also a growing demand for acid carbon steel billets, considerable tonnages of which are being used in the production of war material.

Restriction on the Use of Iron and Steel

The Minister of Supply has made the Control of Iron and Steel (No. 11) Order, which came into force on July 8th, prohibiting, with certain exceptions, the use of iron and steel for buildings except under licence. The intention of the new Order is to prohibit the consumption of iron and steel already in the hands of contractors or consumers, and the sale of iron and steel by stockholding merchants for non-essential buildings. No licence will be required for the use of steel for building, where the purchase of that steel has been authorised by a Department for that purpose under the Steel Distribution Scheme, or has been licensed by the Ministry of Supply (Iron and Steel Control) on or since April 1st, 1940. In order to cover urgent requirements for repairs and maintenance, the use, or the purchase from a stockholder, of less than 1 ton in one month for any particular building is exempt from the licensing scheme. In present circumstances the Minister considers it necessary to prevent any use of iron and steel for non-essential buildings, and licences will only be granted for its consumption for buildings not already authorised, when it can be shown that the building will serve a useful purpose in connection with the war effort. Any application for a licence to use iron or steel under this Order should be made to the Department to which application would be made for authority to purchase steel under the Steel Distribution Scheme.

Maintenance and Repair of Motor Vehicles

Limited supplies of steel for the repair and maintenance of motor vehicles may be obtained from the purchaser's normal stock-holding merchants. No symbol will be needed under the scheme for the distribution of steel supplies, but it will be necessary to declare that the steel is wanted for "Home Civil Requirements—Maintenance of Vehicles." Where the demands cannot be supplied by a stock-holding merchant from his stocks, operators and repairers should write to the Regional Transport Commissioner for the region in which the work is to be carried out for the necessary forms of application to obtain supplies. Accessories and components, being finished goods, may be purchased from the manufacturers or through the usual channels without a symbol.

Copper and Tin

After the collapse of France the American copper market developed weakness owing to the greatly restricted outlet for the metal. With the smaller prospects of an export demand developing the home trade also became quieter since consumers felt that it was unlikely that there would be any pressure to obtain supplies. The export price has dropped back to 10·50c. f.a.s., but the high freights and insurance bring the value almost to British parity. The domestic quotation remains at 11·50c. Neutral buying has practically ceased, and so far as Europe is concerned few of the makers there are in a position to buy. Japan has bought rather freely and Russia would be willing to take up a fair amount of copper, but producers show no inclination to sell to that country. The British Government is understood to be taking up all the surplus metal available from Empire countries, and the war consumption here continues on a heavy scale. . . . News that the American Government intends to buy 75,000 tons of tin as a reserve stock has, of course, exerted a great influence upon the market. It was generally anticipated on this side, when the news became known, that the arrangement by the United States to buy at a price of 50c. per pound would have the effect of establishing an unofficial maximum quotation, and so far this view appears to have been borne out. Apparently the intention is to spread the purchases over a period of twelve months as the opportunity presents itself. Full details of the scheme have not yet been published; but on July 8th the International Tin Committee raised the quota to 130 per cent. of the standard tonnage. The commercial use of the metal seems to be expanding, and in the United States the tin-plate industry is now operating at 80 per cent. of capacity.

Lead and Spelter

The position of lead in Great Britain has not altered much over the week, but there certainly does not appear to be any stringency in the market as supplies are reaching this country with regularity. The Control has been issuing licences for commercial purposes and for export with more freedom, and consumers are now rather comfortably situated. The cable-making industry is working practically at capacity, and is consuming considerable quantities of lead. The battery makers also are busy and are providing a good outlet for the metal. Operations at the pipe and sheet mills are restricted owing to the decline in the demand from the building trades. In the United States consumption is on a fairly good scale, but production is also well maintained and there has been no change in prices. The Mexican position has again become weak since the normal outlet in European countries is no longer available. . . . The spelter market is steady, and whilst there is a large consumption supplies are coming to this country freely. At the same time, the position in Great Britain would appear to be rather tighter than in the case of lead. The brass makers are one of the largest users of the metal, as most of them are engaged upon big war contracts and considerable tonnages find an outlet in this direction. The demand from the galvanisers at the moment seems to be rather quieter, but this is probably because the industry provided for its future needs some little time ago. In view of the heavy requirements of the industries engaged upon war work, it is not surprising that spelter for non-essential needs is not freely obtainable. In the United States the market is steady.

Notes and Memoranda

Rail and Road

DRIVING TESTS SUSPENDED.—The Ministry of Transport has announced that official driving tests have been suspended, except for the small number required for disabled drivers and tests ordered by a court.

SOUTHWOLD-HALESWORTH RAILWAY.—It is announced that the Southwold-Halesworth Railway in Suffolk, which, it will be recalled, was closed down about eleven years ago, is to be dismantled and sold for scrap. The line has a length of about 9 miles.

CONCRETE SLEEPERS.—The Ministry of Transport is preparing a specification for concrete railway sleepers to be used for certain types of new permanent way. It is hoped that they will be used for many miles of new track being laid to serve Government factories.

GAS CONTAINER REGULATIONS.—The Ministry of Transport has issued the Motor Vehicles (Gas Containers) Provisional Regulations, 1940, which gives complete technical requirements for low-pressure and high-pressure gas containers and the associated pipe lines, valves, cocks, and pressure gauges, and for the reducing valves used in conjunction with gas trailers.

STEEL FOR MOTOR REPAIRS.—Limited supplies of steel for the repair and maintenance of motor vehicles may be obtained from normal stock-holding merchants. The Ministry of Transport states that no symbol will be needed under the scheme for the distribution of steel; but it will be necessary to declare that the steel is wanted for home civil requirements for the maintenance of vehicles.

REPAIRED ARMY VEHICLES.—Some hundreds of motor vehicles brought back from France before the evacuation of the B.E.F. have been put into commission again under the repair scheme organised by the Ministry of Supply. This scheme enabled all but the hopelessly damaged vehicles to be brought back to England, where motor garages were given the repair work under the supervision of inspectors from the Ministry.

CANADIAN SCENIC HIGHWAY.—The Columbia Icefield highway, a remarkable scenic highway, was recently officially opened at Athabaska Glacier Chalet, in the Canadian Rockies. The new road ascends to altitudes of nearly 5000ft. in a glacier area and traverses country having a background of apparently limitless snow-capped mountain peaks. It completes the Jasper-Banff highway and crosses the Jasper National Park.

RAILWAYMEN-SOLDIERS.—In an address to the Local Defence Volunteers of the Southern Railway Company, Mr. E. J. Missenden, the general manager, says that volunteers may be well called railwaymen-soldiers. It is upon them, he says, in the first instance, that the successful operation and maintenance of the railway will depend should invasion take place. At certain key posts a resolute defence will have, if needed, a profound effect on the fortunes of the railway which the men have of their own freewill volunteered to defend.

THE MEEKER AVENUE BRIDGE, NEW YORK.—The Meeker Avenue bridge at New York will connect the districts of Brooklyn and Queens and will give access to the Long Island parkways, being later extended to the Triborough bridge. The bridge proper will consist of a 300ft. single-span structure over the navigable Newtown Creek, made up of two steel trusses, spaced 76ft. apart, supported by two towers, 97ft. high. According to the plans the remainder of the structure, the total length of which will be 6415ft., consists of two approach viaducts, again of steel, and containing respectively ten and eleven spans. The twenty-one land piers are raised either on spread footings or on concrete cast-in-place piles. After construction had begun it was found that the soil in certain areas, which had been used for storage of a chemical by-product, had become dangerously acid. Footings already constructed were therefore painted with bitumen, and the back-filling was mixed with slaked lime; the remaining footings were carried to a greater depth than usual and were protected by three-ply waterproof material at the base and by two painted coatings of cut-back bitumen to within 12in. of the proposed ground level. The normal width of the viaducts is 89ft. On the greater part of the structure there will be two footways, each 8ft. wide, two 32ft. carriageways and a 4ft. central reservation; the width of the carriageways will be the same throughout.

Air and Water

ELECTRIC BUOYS IN CANADA.—Fifteen electrically operated buoys, the first electric navigation aids to be used in Canada, have been placed in the Lake St. Louis ship channel. They have replaced acetylene gas buoys, and are claimed to have several advantages, including a diameter of 4ft. 6in. as against 8ft. for the gas buoys, a weight of 2 tons as against 5 tons, and lower maintenance costs.

NEW MOTOR LIFEBOAT.—A motor lifeboat which the Royal National Lifeboat Institution has built for its station at Montrose has arrived at her station. She has cost £3700 and has been built out of a legacy from Mr. Norman J. Nasmyth, of Glenfarg, Perthshire, after whom she will be named. She is the sixteenth motor lifeboat to go to the coast since the outbreak of war, and the second to go to Montrose.

PROHIBITION OF KITE AND BALLOON FLYING.—During the German invasion of Holland it is believed that kites and balloons were flown by German agents to signal to the invading forces and to indicate targets, strategic points or suitable landing places for aircraft and parachutists. The possibility of such subversive activity by enemy agents and traitors in this country, and the possibility that large box kites might be mistaken for enemy parachutists, have received the careful attention of the Air Ministry. The Secretary of State for Air has now made an order under Regulation 7 of the Defence (General) Regulations, 1939, called "The Balloons and Kites (Prohibition of Flying) Order, 1940," which forbids any person, other than a servant of his Majesty, to fly balloons (whether fixed or free) or kites over the United Kingdom except by permit granted by the Air Council or some duly authorised person.

THAMES AIR RAID PRECAUTIONS.—A Port of London Notice to Mariners states that ships in the River Thames are to anchor in such position that, if holed by a bomb in an air raid and liable to sink, they will be able to beach themselves at once in a position where repair and salvage would be facilitated. Vessels should be ready to slip their cables instantly and are to keep steam on main engines so as to be able to get under way immediately on receipt of an air raid warning.

AIR MAIL TO SOUTH AMERICA.—The Postmaster-General announces that the French air service by the direct route to South America and the French air services to North Africa, West Africa and French Indo-China, by which air correspondence from this country has hitherto been forwarded, have been suspended. Air mail correspondence for all South American countries will continue to be accepted for transmission, either by the North Atlantic air service or by surface route to New York, and thence in each case by air.

SYDNEY GRAVING DOCK.—A report from Australia indicates that preliminary work on the construction of a new graving dock at Sydney for capital ships has begun. Sir Leopold Savile, of Sir Alexander Gibb and Partners, had been engaged to advise the Commonwealth Government on the subject, and recommended the construction of such a dock at a cost of £3,000,000. We now learn that Sir Leopold has requested the consulting engineers, of which he is a partner, to make available an expert to advise the Federal Government on the technical points involved.

PROTECTION OF PANAMA CANAL ENTRANCES.—The Panama Canal entrances are to be protected by anti-submarine nets installed along the sides of the channel ready to be slung across in case of necessity. The Pacific side net is already in position and that on the Atlantic side will be installed very soon. Anti-aircraft guns have been installed along the roads throughout the isthmus. Army officials state that the precautions are merely "intensification of training." Both ends of the canal have been mined and heavy guns moved from the Pacific to the Atlantic coast.

LONG LIFE OF AERO ENGINES.—A report has recently been received from New Guinea dealing with aviation activities in that country. It refers to the service which is still being obtained from some Bristol "Jupiter" engines, which are used for air transport between Wau and Salamaua and on other air services in that country. The "Jupiter" engine has not been in production since 1928. Most of the engines in New Guinea started their service there many years ago as second-hand engines, and they have since been operated under very strenuous and severe conditions of climate, with little expenditure upon spare parts. The engines in service in New Guinea have many thousands of hours' flying to their credit.

MERCANTILE LOSSES DUE TO ENEMY ACTION.—During the week ended June 23rd–24th, the total British tonnage lost was 88,259 tons, but of this figure 30,446 tons were lost during combined operations off French ports and are therefore not mercantile losses in the ordinary sense. The figures for this period are accordingly:—British, eight, equals 57,813 tons; Allied, eight, equals 36,750 tons; neutral, eleven, equals 34,882 tons; total twenty-seven, equals 129,445 tons. German mercantile losses up to June 30th amount to about 857,000 tons, and Italian to approximately 229,000 tons. Up to Wednesday, June 26th, 26,355 British, Allied and neutral ships had been convoyed in British convoys with a loss of thirty-seven ships, giving a loss ratio of 1 in 712. Neutral and Allied ships convoyed totalled 5178, with a loss of five, or 1 in 1036.

WORK DURING AIR RAID WARNINGS.—In reply to a question in the House of Commons as to whether arrangements would be made for work to be continued in war industries during periods of air raid warning until local danger appeared imminent, Sir John Anderson, Secretary of State for the Home Department, agreed that it was the view of the Government that such work should be encouraged to continue until it was clear that an attack was imminent. He reminded the House that the position with regard to the giving of public air raid warnings remained in substance as stated on October 25th last. It was then made clear that the Air Officer Commanding-in-Chief, Fighter Command, must in practice exercise a discretion in the giving of warnings and that therefore attack on a limited scale might develop over an area in which no previous warning had been given.

Miscellanea

PRECISION LEVELS FOR ENGINEERING WORKSHOPS.—A draft British Standard Specification for precision levels has been prepared by Technical Committee M E/59, Measuring Tools, and is now being circulated for technical comment. Any remarks on the specification should be submitted to the Institution before August 24th, 1940.

BEAUHARNOIS HYDRO-ELECTRIC PLANT.—It is reported that an increase in the diversion of water from the St. Lawrence River for the development of power in the Beauharnois plant above Montreal has been authorised by the Canadian Parliament as a war measure. An increase of 30,000 cusecs has been authorised, bringing the total diversion to 83,000 cusecs. It will permit the output of the Beauharnois plant to be increased from about 420,000 H.P. to 680,000 H.P. The added power is to go chiefly to Ontario for use by war industries there. The Beauharnois plant is a private power project in Quebec, which is designed ultimately to develop 2,000,000 H.P. at the lower end of a canal around the rapids in the Soulanges section of the St. Lawrence River. The first units in the power plant were put into service in 1932 and additions have been made since that time.

COKE CONTROLLER APPOINTED.—Mr. Leslie O'Connor, of the Interim Committee of the British Hard Coke Association, has been appointed by the Secretary for Mines to be Coke Supplies Officer. Mr. O'Connor will be responsible for the control of hard coke and will carry out certain functions hitherto exercised by the Coal Supplies Officer in this respect.

AMERICAN FLOOD CONTROL DAM.—The Pennsylvania Water and Power Resources Board has approved construction of a 23,000,000 dollar flood control dam on the Conemaugh River near Saltzburg. The proposed reservoir is to be of the flood retention type, about 29 miles above Pittsburg. Much of the preliminary survey work has been completed by Army engineers.

GUIDE TO SPECIALISED INFORMATION.—The Association of Special Libraries and Information Bureaux is publishing "War-time Guides to British Sources of Specialised Information." No. 1 of the series, dealing with "Fuel and Allied Interests (Excluding Electricity)," has just been issued, and is obtainable from the Aslib offices, 31, Museum Street, London, W.C.1, at the prices of 2s. to members and 2s. 6d. to non-members.

BRITISH ENGINEER HONOURED.—Sir Edward Wilshaw, K.C.M.G., chairman of Cable and Wireless, Ltd., has been awarded the Cross of Grand Officer of the Royal Order of of George I. The honour has been conferred by the King of Greece for Sir Edward's work in developing Greek communications, including the erection of transmitting and receiving stations in Athens, the maintenance and operation of wireless telegraph services with other countries, and the handing over to the Greek State of all interior cables operated by Cable and Wireless, Ltd.

PRE-STRESSED CONCRETE CONSTRUCTION.—In the July number of the *Structural Engineer*, the journal of the Institution of Structural Engineers, an informative paper by Mr. T. J. Gueritte describes recent developments of pre-stressed concrete construction with resulting economy in the use of steel. It is pointed out that such construction can be useful for ordinary applications as well as the unusual applications already known. The saving in steel is said to be considerable, rarely being less than 50 per cent. and often reaching 75 per cent. or even more.

WEST OF SCOTLAND GAS GRID.—The question of a gas grid for the West of Scotland was revived recently by Mr. A. S. Nisbet, President of the Waverley Association of Gas Managers, at the Association's annual meeting in Edinburgh. There had been considerable interest a few years ago, he said, in the provision of such a gas grid, to be fed partly from coke ovens, and partly from existing gas undertakings. There was a prospect now, he stated, that one source of coke oven supply would find absorption in the city within whose boundary it was produced.

DUTY-FREE MACHINERY.—The Import Duties (Exemptions) (No. 7) Order, 1940, which came into operation on July 8th, adds to the free list machinery, including machine tools, aeroplanes and seaplanes, ball and roller bearings, ploughs and machinery belting. Exceptions to the order include motor-cars, motor-cycles, and cycles, clocks and watches, musical instruments, telegraph and telephone apparatus, and electrical bell and electrical cooking apparatus. Another order exempts any component parts of such free-listed machinery from Key Industry Duty.

CONTROL OF FIREWORKS.—The Home Secretary has made an order under the Defence Regulations for the control of fireworks capable of being used for giving visible signals to the enemy, such as rockets, maroons, shells, Roman candles and coloured fires. Private persons are prohibited from possessing such fireworks, and are required to surrender to the police any they may have. Ships' lights and signals are exempted from the order, but dealers must keep records of transactions in them, and every purchaser must furnish his name and address at the time of purchase.

TIMBER ARCHES FOR BUILDINGS.—Mr. A. S. Friedman describes in the *Engineering News-Record* how the lower overall dimensions possible through the use of glued laminated timber roof arches have effected construction and maintenance economies in five buildings recently completed by the highway departments of the State of Wisconsin. In all five buildings reinforced concrete buttresses support glued laminated timber arches of uniform cross section. In the usual building of the garage type the central headroom required determines the height of the walls, because the walls must rise at least to the level of the roof truss bottom chord. By using an arch instead of a truss the headroom can be maintained with the height of the walls at the minimum required. In this way materials costs are reduced, and since there is less volume to be heated in cold weather maintenance costs also are reduced.

PERSONAL AND BUSINESS ANNOUNCEMENTS

BRUSH COACHWORK, Ltd., of Loughborough, informs us that Mr. H. Hatton, A.M.I. Mech. E., chief designer of the company, has been appointed acting general manager.

CONTRACTS AND ORDERS

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

SUNBEAM COMMERCIAL VEHICLES, Ltd., Wolverhampton, has received from the Wolverhampton Corporation transport department a twelfth repeat order for ten Sunbeam-B.T.H. trolleybuses.